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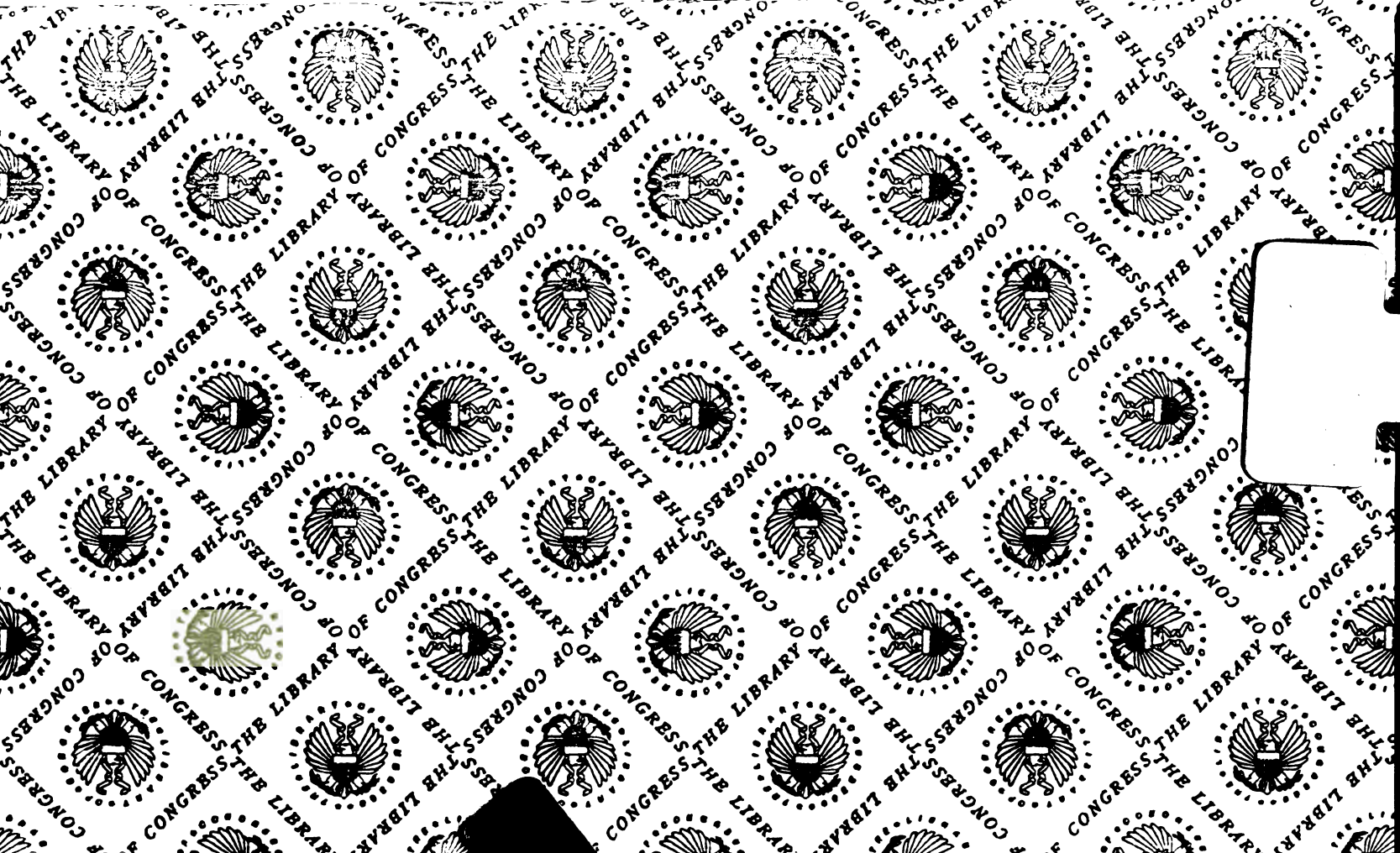
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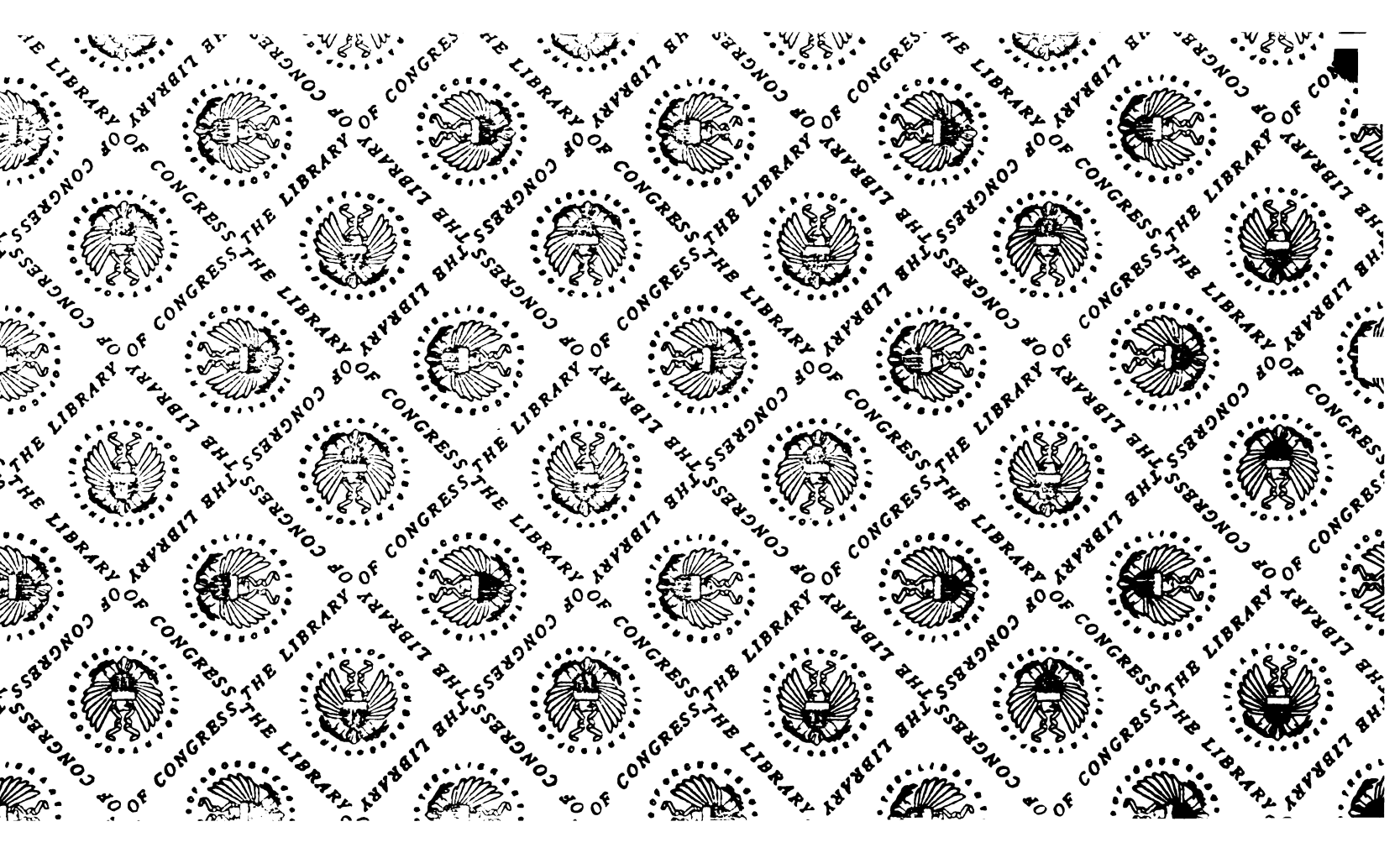
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THE METRIC SYSTEM.

HEARINGS

BEFORE THE

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES

ON

H. R. 93 (58TH CONGRESS, 1ST SESSION); H. R. 2054 (58TH CONGRESS, 2D SESSION), AND H. R. 8988 (59TH CONGRESS, 1ST SESSION).

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METRIC SYSTEM.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., January 21, 1904.

The CHAIRMAN (Hon. JAMES H. SOUTHARD). To-day is the day set apart from the commencement of the hearings on what is known as the "metric-system bill" (H. R. 93), and we have with us representatives from the Merchants' Association of New York and the National Manufacturers' Association.

STATEMENT OF MR. FREDERICK A. HALSEY, M. E., OF NEW YORK CITY.

Mr. HALSEY. Mr. Chairman and gentlemen of the committee, about three years and a half ago Mr. Dale began an investigation into the metric system, and about a year and a half ago I joined forces with him. The object of this investigation has been more especially to determine the actual extent of the use of the system, and also to determine the effect of the concurrent use of two systems of weight and measure, which prevails in all metric countries, and which this system would certainly introduce here. The result of this investigation is contained in this book entitled "The Metric Fallacy," a copy of which I sent to each member of the committee. Now, of course I do not intend to recommend this book to you, but to pick out here and there a few facts which will illustrate my main line of argument.

Mr. GAINES. What is your present business?

Mr. HALSEY. I am at present an editor. I call myself a "literary engineer." By that I mean I was an engineer in the manufacturing of mining machinery for many years until I left it to go on the paper I am now on.

Mr. GAINES. How long have you been studying this metric system?

Mr. HALSEY. About three years. I have eaten and slept with the thing for a year and a half.

The report of this committee of the preceding Congress tells us that this system is used by about two-thirds of the people of the world. And the report of the hearings similar to this of the same committee give us a list of the countries that are supposed to have adopted the system, the number of countries there given being 43. Others, again, tell us that all the countries in the world, except Great Britain, or, I should say, the British Empire, and the United States, have adopted this system; and others are still more specific and attempt to give us the number of millions of people who use it. The

number of millions, I believe, is 480. I wish to be distinctly understood as saying that no man living or dead has ever seen the first scintilla of truth that those statements are correct. As a matter of fact, they are not true. They have no basis in fact whatever, and no basis of any kind except in assumption.

Mr. SHAFROTH. You do not mean to say but that nearly all of the European powers have adopted the system?

Mr. HALSEY. In most of Europe it has been adopted.

Mr. SHAFROTH. And is used there?

Mr. HALSEY. I can not say that. The exact extent to which it is used it is hardly possible to draw figures for, but there are exceptions in every country, including France——

Mr. SHAFROTH. Are you giving this opinion from personal observation?

Mr. HALSEY. You will find all the facts in this book; every source of reference is given.

Mr. SHAFROTH. Are they from your own observation or from somebody else's observation?

Mr. HALSEY. From all sources that are available.

Mr. SHAFROTH. But not by your visiting the countries yourself?

Mr. HALSEY. I have not been there. One can not travel all over the world. I have facts from thirty countries; and it is scarcely feasible for anybody to visit thirty countries for the mere purpose of investigation of this kind.

Mr. GAINES. You say, now, that so many countries in Europe have adopted this system—I believe it is stated it is in use; but is it the only standard?

Mr. HALSEY. It is not the only standard in any country of the world.

Mr. GAINES. Why is it not the only standard?

Mr. HALSEY. Because the change is so difficult now as to have succeeded in making——

Mr. GAINES. How long have they been using it there?

Mr. HALSEY. One hundred and ten years.

Mr. GAINES. How many standards has France?

Mr. HALSEY. Heaven only knows.

The CHAIRMAN. I think it would be fairer to the speaker to hear his statement.

Mr. GAINES. Inasmuch as my friend over here [Mr. Shafroth] who is rather disposed to favor the question, had asked some questions right there, I wanted to get the older thing in the record. I am rather disposed to be for the old thing rather than the new.

Mr. HALSEY. As I say, the initial assumption that these people make is that this change is an easy one, and then, having made that assumption, they follow it up with the assumption that because certain countries have passed certain laws those countries have made the change; and, therefore, other countries having made the change, we can make it. The only difficulty is, the axiom is not true—the change is not easy. So far from being easy, it is so difficult that in no nation in the world is it complete, nor is the end in sight. These people have never inquired into the working of these metric laws; they have never inquired into the working or nature of these laws. They have simply attempted, because laws of some kind have been passed, to take up the system.

Mr. GAINES. What people?

Mr. HALSEY. The people of these various forty-three countries that appear in this appendix. In making that list in your appendix they have, as a matter of fact, included countries in which the laws are simply permissive—exactly as they are here. They have included other countries in which the system has been adopted for governmental purposes alone, and not for compulsory use among the people. In fact, we must distinguish, among these metric countries that appear in your list, three different classes of countries, having three different classes of laws: First, countries in which the laws are simply permissive—exactly as they are here, and our country belongs in that list just as much as those in your list. Second, the countries in which the law simply adopted the system for government purposes alone; and of course in that list it is not proposed our country shall enter. The third class are those in which the laws are compulsory upon the people. I shall attempt to discuss those three classes as briefly as I can, in the order named.

The list which appears in your appendix of metric countries contains the name of Japan. Not long ago our consul at Tokyo, in one of his reports to the State Department, made the statement that it was a mistake to suppose the Japanese had abandoned the measure that she had and taken up with the metrical. As a matter of fact, in their trade and commerce they prefer the old measures, and use them. I sent a copy of that quotation from our consul to the Japanese consul-general in New York, asking him to say if our consul was correct in his statements, and also asked him to make such other observations as he saw fit. I have in my hand the Japanese consul-general's reply, and, being brief, I will read a portion of it:

As to the system of weights and measures used in Japan, the statement of your consul seems to be generally correct. By a law passed in March, 1891, "shaku" was determined as the unit of measure and "kwan" as the unit of weight, definitions being given to both of these units. Although they had been in use for many years past, they were not considered the units, and making of these instruments was not strictly regulated by laws until last year. The same law fixed the ratio of shaku and kwan to the metric system, and vice versa, legalizing the use of the metric system. But in the ordinary trade and industries our own weights and measures are commonly used instead of the metric system, although in the army and the navy they generally use the English, or metric system.

There, I ought to remark, the army and navy, in a modern sense, are a recent importation into Japan. They have been taken from Europe, and they could not have helped themselves if they tried.

In our government statistical publications anything other than our own weights and measures is very rarely used. In our tariff schedules specific duties are mostly fixed by our own weights and measures, by which some articles are to pay duties by gallons, feet, yards, liters, tons, etc.

Mr. SHAFROTH. Now, is it not a fact that in Japan the ordinary scales—for weighing a man, for instance—are all graduated according to the metric system?

Mr. HALSEY. I have no specific information about those scales. I have this, which says their ordinary units are not metric. That is all I have from Japan. I have here a copy of the Japanese tariff schedule, published by the Philadelphia Commercial Museum. Of course the crucial test of the use of a system of weights and measures is its use in the tariff schedule. If you will examine this schedule you will

find exactly nine items on which the duties are levied by metric units, these nine articles being successively wines, spirits, malt liquors, and tinctures. You will find items, such as champagne, on which duties are levied by the Government, but on which the size of the bottles is specified in metric units. In other words, you will find a total of 14 items on which the duties are levied by metric units. Neither meter nor kilogram appear in this list. Of course in most tariff schedules—in fact, in all tariff schedules—the great majority of tariff duties are levied by units of weight, as they are here, and you will find universally that the unit of weight in this schedule is the kin. I think it is clear that any talk about Japan being metric must be dismissed.

This list in your appendix of two years ago also tells us that Turkey is a metric country. I will refer you to this book——

A MEMBER. What book?

Mr. HALSEY. This book [indicating], The Metric Fallacy. The situation in Turkey is not essentially different to-day from what it is in Japan. No attempt was ever made in Turkey to introduce this system in the provinces. There was a serious attempt made to introduce it in Constantinople. After giving five years' notice, the Turkish Government proceeded to destroy all the weights and measures that could be found. That is the gentle way they have of propagating reform. They found they had undertaken more than they could carry out. In due season the old weights and measures surreptitiously made their appearance again, and, after a fight, the Government gave up the fight in disgust. It reenacted the old weights and measures.

Mr. HEDGE. How long ago was that?

Mr. HALSEY. I can not tell. It is simply permissive; but judging from what we know about Turkey, we apprehend that it seems to mean that you will sell or buy goods by the metric system in Turkey, if you want to, without danger of going to jail for it. It would appear from this that this programme, upon which these metric gentlemen would have this Government enter upon so lightly, is one before which the Sultan of Turkey was compelled to confess defeat.

They tell us that China is metric in 23 treaty ports. I wrote to the Chinese consul in New York, asking the extent of the system, and I have in my hand his reply, signed "L. Wing," who is the Chinese vice-consul, as follows:

> In reply to your letter of inquiry about the metric system of weight and measure used in China I can only state, to my knowledge, that the metric system is not used so much as it is supposed. Among our people, the Chinese weight and measure are used; among the foreigners, the English weight and measure. But when natives and foreigners trade with each other the Chinese standard of measurement is used if the merchandise is Chinese, and vice versa. The tariff schedule is based on the Chinese standard of weight and measurement.

Mr. GAINES. What is the date of that letter?

Mr. HALSEY. It is dated October 20, 1903.

Of course, from our present standpoint, the list of countries which is of most interest to us is comprised of those in which this system has been adopted for government purposes, because the experience of those countries is, of course, of immediate office application. This list is much longer than the other. It begins with Greece, and——

The CHAIRMAN. Just a moment. What about Mexico?

Mr. HALSEY. I am coming to Mexico presently. It is compulsory there. It comes in the third classification. The three classifications are those in which the system is permissive, those in which it is adopted for the Government, and, third, in which it is compulsory.

I am now taking up the second class, in which it has been adopted for the Government. This list is longer than the other, and begins with Greece. This system was adopted in Greece for government purposes in 1836, and the people do not use it yet. The same is true of Egypt, although the date there is not so far back; I do not know what the date is. My source of information regarding Egypt and Greece is metric; it comes from Paris, the metric headquarters of the world. And the reporter has given about as discouraging a view of the situation in Greece as he could state in words. Finally, as a comfort to himself and friends, he wound up by saying that the system is taught in the study schools. That seems to be the end of it; the children learn it, but nobody makes use of it.

The system has been tried in this way in many of the countries of Spanish America, apparently in nearly all of them. So far as I can learn, the only Spanish-American countries in which the system is compulsory are Mexico and Uruguay, and, perhaps, Brazil. My advices regarding Brazil are somewhat conflicting. Although they are not conflicting as regards the use of the system, as regards its local status there is some uncertainty. It has been thus adopted for government purposes in Honduras, Salvador, Costa Rica, Nicaragua, in Colombia, Venezuela, and Peru; and, perhaps of more interest still to us, it has been adopted at our very doors, in Cuba. Of course, I can not repeat to you all the evidence I have from all these countries. If you wish to see it, you will find it in this book.

Mr. GAINES. What have they adopted besides a republican form of government and constitution in Panama?

Mr. HALSEY. Panama I have not got to yet.

The testimony from all these countries is the same, that the adoption of the system by the Government has always failed to bring about its adoption by the people.

Because of our proximity to Cuba, and the interest we take in Cuba, I will read you some of the testimony I have from there, although I will omit all the others. This letter is from Alberto de Verasteguy, who was formerly Cuban agent for the Babcock & Wilcox Boiler Company, the largest makers of water-tube boilers in the world. This gentleman, as I have said, was their agent in Cuba. I may say that he is either a Spaniard or Spanish-American, I am not sure which. He believes in the metric system in the earlier part of this letter, which I do not reproduce; he proceeds to say how much he believes in it, and then to berate people because they do not use it. Of course that kind of thing is what I like best. As follows——

Mr. SHAFROTH. Do you not think that the use of so many of those standards, or so many of those weights, would be very confusing, and there ought to be a tendency toward one?

Mr. HALSEY. Certainly it must be vastly confusing.

Mr. SHAFROTH. Do you not think it would be to the interest of everybody to unify to one, if it is possible?

Mr. HALSEY. I think we are legislating for ourselves, not for them.

Mr. SHAFROTH. If it is good for them, would it not be good for us?

Mr. HALSEY. That is not the point. The point is that you gentlemen have been told of the wonderful uniformity and perfection of these measures in these countries. They have the most confusing measures. If you want to find a condition where it is not confusing, you must come here or go to England. We have the most uniform system of weights and measures in the world.

Mr. SHAFROTH. Has any other country adopted our system?

Mr. HALSEY. It is spreading all over the world.

Mr. SHAFROTH. Is there any law adopting the system in any other countries?

Mr. HALSEY. No, sir; in the United States.

The CHAIRMAN. Anywhere in the world?

Mr. HALSEY. In England.

Mr. GAINES. And yet all the world is glad to buy from us, and we are glad to sell to them, all the time, and they are buying all the time, and do they not buy by our measures?

Mr. HALSEY. Certainly.

Mr. SHAFROTH. Is not that irrespective of the fact of what it is measured in? They are buying the things, not the measures.

Mr. HALSEY. But you told us we must do this thing for the benefit of foreign commerce.

Mr. GAINES. Mr. Shafroth asks you if it would not be well for this country and other countries to have one standard of measurement?

Mr. HALSEY. It certainly would.

Mr. GAINES. Is not this the most complex system that is known, and the hardest to understand?

Mr. HALSEY. Let me answer the question as you have given it. It undoubtedly would be advantageous if the whole world had the same system of weights and measures. It would be far more advantageous if all the world had the same language; and one proposition is just as chimerical as the other. The metric system in its purity, and what it should be, is simple. That is not the point. The metric system in use in other countries is very complex. They have never gotten rid of their old measures, any of them.

Mr. SHAFROTH. You mean to say that they have not absolutely excluded all of their old measures?

Mr. HALSEY. As Mr. Dale states, the textile industry does not use it at all.

Mr. SHAFROTH. We use, in parts of the country, reference to "bits" and "shillings," and you would not say those were material?

Mr. HALSEY. I was raised on the New York shilling; I know all about it, and I can think in New York shillings as well as in dimes—perhaps better. What has survived is the name and not the thing.

Continuing with Cuba, I have here a report from Mr. H. D. Dumont, who went to Cuba as commissioner for the New York Merchants' Association. This report, primarily, has nothing to do with this subject; but in it you will find a number of references to various commercial and agricultural matters, profits realized in raising different kinds of crops, and so on. In making these comparisons and these figures, it is necessary to use the unit of land measure. You will not find any reference to the metric system.

Mr. GAINES. What is the date of that?

Mr. HALSEY. May, 1903.

A MEMBER. Is it published for Cuba or America?

Mr. HALSEY. It is published for America. No; they use the Spanish measure, not ours. They use, in other words, the ordinary measures that are used in Cuba.

I have here a copy of the monthly publication of the International Bureau of American Republics for September, 1903. You will find on page xvii—published, I take it, from standing type; it comes into our office every month—a table which gives the chief weights and measures in commercial use in Mexico and the republics of Central and South America and their equivalents in the United States. In this table you will find something like 49 metric units.

The CHAIRMAN. Suppose anybody should attempt to make a list of the weights and measures used in this country, or any other country, would he not have very many units that are not what you may properly call English units?

Mr. HALSEY. He might find it so; certainly. The point I have made is, that the metric system is not established there in the sense in which it has been represented. In point of fact, they use the metric system but little outside of government purposes. The testimony from those countries is all to that effect, that the government use of the thing has not led to its use in commence and industry.

Mr. SHAFROTH. If a metric bill were to be adopted in this country, what would you advise that it be—a bill requiring the Government to adopt, or a bill making it compulsory?

Mr. HALSEY. I would not advise any bill.

Mr. SHAFROTH. But between the two?

Mr. HALSEY. I do not think I would choose between the two. The best thing to be done in this Government is to let the thing alone. We have gotten along as we are better than any country in the world. Our weights and measures are better than in England today, because the Government has let the people alone.

Mr. GAINES. It seems from what you have said that where a government has adopted it at all it has been able to make the government, as such, use it, but has not been able to make the people use it?

Mr. HALSEY. That is the idea exactly.

Mr. GAINES. Even though it has compulsory laws?

Mr. HALSEY. I have not got to compulsory laws yet.

While I am upon the subject of Spanish America I will take up the Philippine Islands. You gentlemen were told two years ago how the wise Government of Spain had established this thing in the Philippine Islands, and that, therefore, for some unknown reason we ought to do it here. I have here two letters from Rev. George D. Rice, who is chaplain of an American regiment in the Philippine Islands, and I will read a short portion from them. One is dated from Manila, October 3, and one from Manila, October 6, 1903.

In nearly every business house, manufacturing establishment, and Government institution here scales are used with pounds on one side of the balancing arm and kilos on the other. I find this state exists everywhere in the islands. This is necessary, because sometimes the metric system is required. The little railway of Luzon will not receive goods unless the invoices are given with weights in kilos.

Mr. SHAFROTH. "On the other side" is it in Spanish pounds or in English pounds?

Mr. HALSEY. He says, "Pounds on one side." He does not state whether Spanish or English.

The CHAIRMAN. Presumably Spanish?

Mr. HALSEY. Presumably Spanish.

Mr. GAINES. What is the difference between the Spanish and American pound?

Mr. HALSEY. The Spanish pounds are so many that I can not tell you.

His other letter says:

Yesterday I visited the Chinese scale makers of Manila. They have quite extensive works. I found them making most of the scales as per inclosed. The balance beam is marked with American pounds and with Spanish characters. There are 5 American pounds to each Spanish arro. These scales are cheap and extensively used in the shops, stores, and plantations of the islands.

We come next to the countries in which the system has been adopted by compulsory law, and we find there conditions that are in some respects the most interesting and instructive of the whole lot, these conditions being due to the operation of a very simple principle, which is so simple as to be almost self-obvious when once started, but which I believe hitherto has escaped observation entirely. This system is, that in any country in which individuals have no rights whatever the compulsory laws can not be made to apply to factory and commercial measurements. By commercial measurements I mean weights made when goods are sold; by factory measurements, measurements made when goods are made.

Such testimony as you gentlemen have regarding the use of this system abroad relates exclusively to commercial measurements. The tourist goes to France and buys goods by kilogram and meter, and does not find anything, but thinks the system is universal. As a matter of fact, he knows not what goes on behind closed doors. The average tourist could not get in if he tried; but if he succeeded in getting in there he could not learn a thing from what he saw unless he was acquainted with the industry. This whole field of factory measurement was practically untouched until Mr. Dale and I took it up, and we found a "field ripe for the sickle."

Compulsory law does not apply to factory measurements. The law in which there are no statutory limitations may undoubtedly prescribe the weights to be used, but goods as made in factory have been marked, are commonly made, in advance of such transactions. While they are being made, and until they are sold, they are absolutely the property of the maker, and it is inconceivable that, in a country where the individual has any rights at all, that the law should step in and tell him how he should make those goods. The laws in Germany say, "You shall not sell that bolt," if somebody wishes to buy it, or buy it, if they have use for it. In this case, the unit must be metric, but the dimensions of the goods can be anything whatever. In other words, the tendency of these compulsory laws is simply to plaster a new set of commercial units on top of the old system of factory units; and of course this is done in the sacred name of uniformity.

Do not understand me to say that these laws in regard to commercial measurement are completely successful, because they are not. There are many exceptions to the commercial use in these countries, but, nevertheless, the success of the laws has been, relatively speaking, greater in connection with commercial measurements than in connection with factory measurements. This principle that these laws do

not apply to factory measurements sticks up everywhere throughout this inquiry; it is as prominent as a sore thumb. If you go to Mexico you will find the lumber industry is conducted just as it is here, by which I mean that lumber is sawed in length, width, and thickness in inches. When the bill comes in it calls for so many square meters. I was told that by an engineer in Mexico. I know a firm in Indianapolis that have a large trade in Spanish America for sawmills. In their catalogue six years ago they placed a statement that they would supply metric set work—by which the thickness of the boards was gauged—on demand, without extra cost, but that, if not requested, they would supply the English set works; and in six years time they have not had so much as an inquiry for metric work.

Mr. GAINES. Who is this engineer to whom you allude?

Mr. HALSEY. Chandler & Taylor, of Indianapolis.

Mr. GAINES. Is that the name of the civil engineer who gave you this information?

Mr. HALSEY. You mean about lumber?

Mr. GAINES. You allude to a civil engineer.

Mr. HALSEY. A mining engineer, Mr. J. Parke Channing.

The CHAIRMAN. I wish to inquire a little particularly about Mexico, because, if I remember correctly, at a meeting at the Sturtevant House, about a year ago, in conversation with you, you disputed the fact that they used the metric system generally in Mexico. A few weeks after that I had occasion to go to Mexico. I was there about three weeks, and traveled from El Paso to the Isthmus, stopping at various places—Mexico City, Veracruz, and a number of other cities; and, as best I could, I made inquiry of Americans and of Mexicans as to the commercial transactions and what system was used in manufacturing where manufacturing exists—of course there is not much manufacturing done in Mexico—and it appeared to me that the metrical system was as generally in use in that country, notwithstanding its recent adoption, as our system is here.

Mr. HALSEY. I have no doubt the metric system is in common use in Mexico commercially. The average man sees only the commercial side of it.

The CHAIRMAN. I talked with a gentleman who was going into the manufacture of cars. He said they had mechanics who worked in either system, in one as well as in the other; and the people there all understood the metric system perfectly, were well pleased with it, and would not think of returning to any other. And that is what both the Americans and the Mexicans told me in reference to the system there.

Mr. HALSEY. Now, Mr. Chairman, I have in this book—I have not attempted to repeat it here—a letter from the master mechanic, or, I think, he calls himself the superintendent of motive power, of the Mexican Central Railroad, and he says that all of their shop measurements of locomotives, cars, tools, everything else are made in the English system. The view that the ordinary man gets is the commercial view. He does not know anything about what is going on inside of the factory. I am told by Mr. Channing that the lumber industry is done there as it is here, except it is done by the square meter.

The CHAIRMAN. I want to say right here that somebody—I do not know who—has been writing to the manufacturers throughout the

country, designating this measure as a compulsory bill for the adoption of the metric system, creating the impression that it is a bill of general application throughout the country, and that in terms it is compulsory. I have been obliged to answer and say that this is not, in that sense, a compulsory bill.

Mr. HALSEY. I think I understand the scope of this bill perfectly well, Mr. Chairman.

The CHAIRMAN. I do not know who has been doing that, but I have letters now, I think, from half a dozen of manufacturers—the Warnicke Company, the Ford Glass Company, which has a large institution over near Detroit, and they also have the largest plate-glass factory in the world in Toledo—and from a number of others strongly urging the adoption of the metric system, which indicate that the manufacturers of this country are divided.

Mr. HALSEY. I shall touch upon the scope of this bill presently.

On page 55 of this book is the statement of Mr. Ben Johnson, who is superintendent of machinery for the Mexican Central Railroad. That man was a classmate of mine, and I know him very well. You can not get around testimony of that kind.

The CHAIRMAN. I noticed that all the measurements, the signs along the railroad, are all in the metric language—the capacity of the cars, and everything else.

Mr. HALSEY. Undoubtedly the capacity of the cars is indicated that way.

Mr. SHAFROTH. That is true in the Philippine Islands, too.

Mr. HALSEY. What figure does that cut? There is one weight required to fill that car, and a thousand measurements to get that.

Mr. GAINES. The railroad can always force its employees to do what it wants, generally.

Mr. HALSEY. Certainly.

The CHAIRMAN. I noticed the common people in Mexico all use the metric system. If they can use it and apply it without inconvenience, wherein would come the inconvenience to educated men?

Mr. HALSEY. That is not the difficulty, Mr. Chairman. The difficulty of this thing is of a technical nature; it is hard for me to get it in here. It is the physical difficulty of the manufacturer making the change. Doctor Stratton told you the chief difficulty of all was learning to think in the new system. That is only the beginning of it—to the manufacturer that is the beginning of his difficulties. He has not yet got, and will not, the "A, B, and C" of the subject.

Mr. BATES. Do you not think that Congress ought to legislate for more than to-day and this year, and that, if it is the best system, it ought to be adopted? You know the Westinghouse Company. Mr. George Westinghouse came before this committee and advocated a change. Is not that a practical company?

Mr. HALSEY. Certainly. But Mr. McFarland, vice-president of the company, came here and opposed it.

The CHAIRMAN. Take the General Electric Company. Mr. Elihu Thomson, not desiring to give his own opinion as being that of the company, addressed a letter to the heads of the departments, and a large part of them, with but one exception, all advised the adoption of the metric system.

Mr. GAINES. You say that Mr. McFarland, of the Westinghouse Company, came here and opposed it?

Mr. HALSEY. Yes, sir.

Mr. GAINES. Why?

Mr. HALSEY. Because he thought it was a great mistake.

Mr. GAINES. How old a man is he?

Mr. HALSEY. He is about 50 years old. He appeared in opposition to the bill.

So far as my knowledge goes, I think Mr. Westinghouse is about the only man you could find there that believes the thing ought to be done. I will tell you one thing about the Westinghouse Company. I have a striking fact from the Westinghouse Company, which I have from their chief inspector, Mr. Thomas. The standard American half-inch screw contains 13 threads per inch; the English, 12 threads per inch. Mr. Walsh, the former superintendent of the Westinghouse Company, was opposed to an odd-numbered thread and he adopted the standard American thread for their bolts, for which he made the threads 12 instead of 13, the shape being American shape, however. That has been a nuisance from that time to this. The difficulty is that when they order bolts they must remember, or they will find 12,000 or 13,000 bolts on hand that they can not use. I have that from Mr. Herman Westinghouse. They think they can not make a change of bolts because of the history they have behind them; one single half-inch bolt can not be changed by as powerful a company as the Westinghouse.

Mr. GAINES. Who is Herman Westinghouse?

Mr. HALSEY. He is the inventor of the Westinghouse engine.

A MEMBER. He is George's brother.

Mr. HALSEY. I do not know that he is a brother; but he is manager there to-day.

I am told by Mr. Channing that the lumber industry in Mexico is done as it is here, except your bill calls for so many meters of 1-inch lumber. The same is true of the iron industry; and if you buy some bar iron you will find that your bill will call for so many kilometers of 1-inch bar iron. You will observe the operation of this principle I have laid down, that the commercial units are metric and the mill units are English. The dimensions of the lumber are English; but the commercial unit, by which the merchant expects his price, is metric. In other words, the effect of the compulsory law has been to change the commercial units.

I have a highly interesting letter from this same Mr. Channing. He is president of the Tennessee Copper Company. He is a very good mining engineer, and he has seen much of Mexico as such. He was there last summer. He knew of this inquiry of mine before he went, and promised to look it up. This letter will tell you how they mix gold, silver, and lead.

When the ore contains 5 per cent of lead or more, it is paid for at 1 cent United States currency per pound when soft Spanish lead is quoted in London at £13 per ton of 2,240 pounds. For each advance or decline of 1s. 3d. in the London quotation 1 cent United States currency per 100 pounds for lead contents will be added or deducted.

This ore, however, is weighed and deliveries made in kilos, and assays are reported in grams per metric ton of 1,000 kilos.

The silver is paid for at 90½ per cent of New York quotation, which is in United States currency per troy ounce. The gold, however, is paid for at $0.6269 United States currency per gram.

Freight and treatment charge are $24.50 Mexican currency per ton of 2,000 pounds avoirdupois.

I think you have in the above a case nearly as complicated as that of the manufacture of cloth in France.

Mr. SHAFROTH. Would not all that be avoided if the United States and England would adopt the metric system?

Mr. HALSEY. No; no. This came from Mexico, where you gentlemen were told the thing was working magnificently, where they made the change over night. This shows the effect of this very thing. Before the metric system was adopted in Mexico they had four units to deal with; now they have six. It has added the metric system, but has not gotten rid of the old units.

Mr. SHAFROTH. Do you mean that the Spanish units are used to any extent?

Mr. HALSEY. Not in this case.

Mr. SHAFROTH. Before the adoption of the metric system in Mexico the Spanish units were used?

Mr. HALSEY. Partly.

Mr. SHAFROTH. Do you not think it was of some advantage to Mexico to adopt the metric system instead of sticking to the old Spanish units?

Mr. HALSEY. I can not size the whole case for Mexico, but I know in this case they have made the thing worse instead of better.

Mr. SHAFROTH. Do you think the Spanish units were better than the metric units?

Mr. HALSEY. It is not a question of which is worse——

Mr. SHAFROTH. Do you not think the change from the Spanish to metric units was desirable?

Mr. HALSEY. I can not say. I am not sufficiently acquainted with the facts as they existed in Mexico at that time. Now, here is a thing from a Mr. Kendig, on page 55 of this book, as follows:

About a year ago I was sent by the company to the State of Chihuahua to superintend some new metallurgical operations, and it is surprising to me at this time to see the Babel of standards. The survey of the land upon which the works are built, as well as all levels, are in the metric system. The plans for all buildings and machinery are in the American system. A building so many feet long and so many feet wide is on such and such a meter level. All lumber ordered from Texas, or from mills in the Sierra Madre Mountains, is ordered so many inches by so many feet in the customary United States sizes. Local dealers sell you so many meters of such or such inch pipe, and the bill so reads. All valves and fittings come in inches. Of merchant iron you buy so many kilos of the dimensions given in inches, and I have a list card from one of the Mexican manufacturers of bar and sheet iron giving the dimensions in one-half, one-fourth, one-eighth, and one-sixteenth of an inch that would suit the most conservative of your correspondents. Obliging salesmen in the stores can always give you the price in "metros" or "varas." Your cord wood has to be converted from "cargas" and your hay or straw from "arrobas."

That man is on the ground and has lived there for years, and ought to know something about it.

Mr. SHAFROTH. Do you not think that occurs in Mexico because of the great commerce they have with the United States and buying American goods?

Mr. HALSEY. But, remember the lumber is made there; remember this iron is rolled there; remember that this hay and straw, measured in the old Spanish units——

A MEMBER. You say the iron is rolled there?

Mr. HALSEY. A large part of it.

The CHAIRMAN. Do they not import most of the iron and steel from the United States?

Mr. HALSEY. I do not know.

A MEMBER. They have a big iron works there.

Mr. GAINES. It is a free-silver country; they have got everything there.

Mr. SHAFROTH. Does not this confusion in Mexico itself, and the want of adherence to the metric system arise very largely because of the system existing in the United States, and pushing itself by means of commerce on this people?

Mr. HALSEY. Undoubtedly. It shows the strength of commercial strife in these matters.

Mr. SHAFROTH. Do you not think there ought to be a tendency to unification of standard instead of diversity of standard?

Mr. HALSEY. I think so. Their attempts have brought about diversity instead of uniformity; and that is what your bill is going to do.

Mr. SHAFROTH. It has not done so with the systems of England and the United States?

Mr. HALSEY. We can not get away from our past.

Mr. GAINES. I understand that one proposition you are answering—that is, rather covered it in this delightful argument you are giving—is this, that the testimony heretofore tends to show that Mexico is one of the countries in which the metric system is universally used?

Mr. HALSEY. I am showing it is not. I am showing that the testimony given to you is false; I am showing you, by capable testimony, that compulsory laws are failures. What the reason is I do not know.

The CHAIRMAN. Do you not think you could go down to the Mint of the United States and find a case where they use the metric system?

Mr. HALSEY. Chemists commonly use the metric system.

The CHAIRMAN. Do you not suppose you could get samples of as great diversity of measures there as you can in Mexico?

Mr. HALSEY. I am not showing, primarily, the diversity of measures in Mexico. I am showing that the laws to adopt the metric system there have been failures.

Mr. SHAFROTH. Does it show they are failures? We have had failures here.

Mr. HALSEY. I should say if a law has been in force for nineteen years, as it has in Mexico, compelling the use of the metric system, and these exhibits can be made showing the extent to which it is not used, that law is a failure.

Mr. GAINES. When did we undertake by law to adopt the metric system?

Mr. HALSEY. I think our permissive law dates from 1866.

The CHAIRMAN. When was it adopted in Mexico?

Mr. HALSEY. On January 4, 1884, I think it was.

The CHAIRMAN. My recollection is that it was later.

Mr. COCKRAN. Is it not true that a very large per cent of the manufactured commodities consumed in Mexico are imported?

Mr. HALSEY. I expect they are.

Mr. COCKRAN. Is it not true that at least 90 per cent of the steel and iron products are imported?

Mr. HALSEY. I do not know anything about the figures.

Mr. COCKRAN. Now, the quotations of prices to them are from the United States and England largely, that do not use the metric system.

Mr. HALSEY. The primary quotations, probably; yes, sir.

Mr. COCKRAN. That necessitates a system there by which their merchants have the same difficulty in resolving a pound into grams, and so on, that we have in resolving pounds and pence into dollars?

Mr. HALSEY. I understand what you are pointing at.

Mr. COCKRAN. Is it true?

Mr. HALSEY. I think you are probably right.

Mr. COCKRAN. Now, in the end, then, the preponderance in the quantity of trade determines the units used in the correspondence of commerce and in everything relating to that import trade?

Mr. HALSEY. Undoubtedly the forces of trade and commerce exceed those of legislation.

Mr. COCKRAN. Would not that account for most of the causes you have pointed out as indicating the extent to which in the internal affairs of Mexico the system has been adopted?

Mr. HALSEY. It might account for some of it.

Mr. COCKRAN. Would it not account for all of it, as related to the foreign trade?

Mr. HALSEY. When I go further along I shall show you that in some communities in France they have used the old measures for one hundred and ten years. The silk industry in France, which is a self-contained industry, does not use in their mills to-day the old system at all. I am answering this argument that has been made that this change is due to the force of international trade.

Mr. COCKRAN. You would not state that in France conspicuously, and to a great extent in central Europe, the metric system is not the uniform——

Mr. HALSEY. The inside of the factories have never been open to observation at all. Your argument was that it is the force of international trade where it is kept in Mexico. In France, where the industry is self-contained, at home they still adhere to the old measures.

Mr. COCKRAN. The only purpose I had was to account for the mention of so many units in single transactions and as rather going to show that it is not necessarily proof that in the ordinary traffic and trade of the people of Mexico the metric system has not been largely adopted.

Mr. HALSEY. Undoubtedly the forces of trade and commerce are large forces in these matters, but you can not accept the situation as a safe one, for the reason that in France the same condition exists——

Mr. COCKRAN. I will ask you if, during the whole history of trade between this country and England, the quotation of the price of grain by England has not been in quarters, as they call it, and if, in so far as that relates to the grain trade between the United States and Great Britain, that is not the method used in quoting prices to them by our grain exporters and in their propositions to us in reference to that?

Mr. HALSEY. I do not know anything about that trade.

Mr. COCKRAN. Well, it is true.

A MEMBER. The Mexican merchant does not ask you to make quotations to him in the metric system, but asks you to make the invoices, to go through the custom-house, in the metric system.

Mr. SHAFROTH. That is on account of the dominating influence of the United States in the trade.

Mr. HALSEY. You observe the point I make. In the lumber industry in Mexico—they make their own lumber and build their own houses—even in the sawmill industry, the effect of the adoption of this system, the passage of these laws, has been to add the new units and not get rid of the old ones.

Mr. COCKRAN. Is it not true that all the Spanish-American states and Brazil have adopted the metric system?

Mr. HALSEY. For government use, as I said a while ago; few of them have made it compulsory.

Mr. COCKRAN. Is it not true that the legal standard of measurements through Europe is the metric system?

Mr. HALSEY. Largely; yes.

Mr. COCKRAN. The only countries, then, of considerable importance that do not use the metric system in commerce are the United States——

Mr. HALSEY. The British Empire and the United States; and here is Japan, I just told you about, and China and Turkey, and some parts of the world I have not yet covered.

Mr. COCKRAN. The western world I am speaking of particularly. Is it not true, then, in your judgment, could you overcome these provincial habits of thought and commerce, and what is sought here could be done, that it would be better than the system existing?

Mr. HALSEY. No; I do not. I believe the turmoil involved would cost a million times what it was worth. The whole thing is not worth anything.

Mr. COCKRAN. When accomplished, do you not think it would be better?

Mr. HALSEY. No; not much better.

Mr. COCKRAN. You regard, then, a system which necessarily compels a correspondent to use eight units in mentioning the prices of commodities, in a single letter there, better than one that uses one unit?

Mr. HALSEY. I do not think there is any comparison at all.

Mr. COCKRAN. If it is true that central Europe—the "continental powers," as they are called—and the Latin republics, and Brazil have adopted the metric system, that would comprise probably three-fourths of what is called the "western nations," would it not, in population?

Mr. HALSEY. Maybe.

Mr. COCKRAN. Then the tendency of three-fourths of the population is in the direction of the unification of weights and measures, and they are making the effort; and if this be true is it not also apparent that, as they approach a unity of weights and measures, it will be well for us to undertake it, so as to be in harmony with the world?

Mr. HALSEY. Not at all. The conditions are absolutely different. We have to-day what the rest of the world has adopted the metric system for. The condition in France when the metric system was originated was one of absolute chaos; units having the same name

but different values in different provinces and towns. The same thing was true in Germany when the German Empire was formed. Every little principality had its own system of weights and measures; and when that country got together and the German Empire was formed it was an absolute necessity that they have one system, and, in other words, without change of some sort they had a case of diversity of which we have no knowledge whatever. They adopted the system to secure uniformity, and uniformity is to-day the very thing we have got without the metric system.

Mr. COCKRAN. Uniform with what? Ourselves?

Mr. HALSEY. Certainly. Throughout the country we have the same foot and pound and yard, and likewise throughout England, except the unit of capacity.

A MEMBER. You say the same pound. What do I understand the pound to be?

Mr. HALSEY. The only pound you and I know—the avoirdupois pound.

The CHAIRMAN. The only pound we have adopted in this country is the Troy pound.

Mr. HALSEY. You have never seen a Troy pound in your life; you never saw one in commercial use.

The CHAIRMAN. Do they not have them down at the Mint?

Mr. HALSEY. They have Troy ounces there. You never saw figures of gold and silver throughout the world given in pounds. They are always given in thousands of ounces.

The CHAIRMAN. What do you understand by the ounce?

Mr. HALSEY. Ordinarily I understand the commercial ounce.

The CHAIRMAN. Ordinarily; but there are exceptions to that, are there not?

Mr. HALSEY. There is the gold and silver ounce.

The CHAIRMAN. The apothecary's ounce?

Mr. HALSEY. Yes, sir.

The CHAIRMAN. There are these different ounces, then. What do you understand by quart?

Mr. HALSEY. If it is a quart of peanuts I understand it is the dry quart; if a quart of milk I understand it is the wet quart. If you buy a quart of peanuts you know what you are getting. There is no confusion, because they are used for different purposes. Now, the Troy ounce for weighing gold and silver is analogous to the carat used for weighing gems. It is used as much in Paris as it is here.

Mr. SHAFROTH. In my country they sell 2,000 pounds of coal for a ton; down here it is 2,240.

The CHAIRMAN. Is not some confusion apt to arise from these different units having the same name?

Mr. HALSEY. Were you ever confused in your life because the quart by which you buy peanuts was different from the quart by which you buy milk? Understand me distinctly, it would not be better if we had one quart.

Mr. GAINES. You say, now, we have an apothecary, an avoirdupois, and a Troy weight; when one goes in a drug store he knows the drugs are weighed by apothecary's weight?

Mr. HALSEY. Except for prescriptions.

Mr. GAINES. If you go in there and get a pound of anything, they

are going to weigh it according to the weights that are used by the apothecary, and——

Mr. SHAFROTH. They would weigh that by avoirdupois.

Mr. GAINES. What I want to get at is, that the weight measures we use are well known by everybody. They use one for one thing, and everybody understands that; and we use another weight for one strata of business, and everybody understands that?

Mr. HALSEY. Certainly. And, furthermore, whatever you buy in a drug store is bought by the avoirdupois pound, unless it is on a physician's prescription. Apothecary's weight is weight between physicians and druggists, and nobody else uses it. If they want to use it it is their own affair, and all the laws you can pass are not going to get rid of it.

Going back to the principle again, that these compulsory laws do not apply to factory measurements, we find other illustrations in Germany. Among them is the use of English screw threads and English pipe. The use of English screw threads in Germany was enlarged upon in these hearings two years ago, and you gentlemen were given to understand that it was simply a special and sporadic case of the persistence of English units. In point of fact it was nothing of the kind. It was simply an illustration of the fact that the laws of Germany do not apply to factory measurements. But so much has been said about the use of English screw threads by Germany, that I will not enlarge upon that, because I have a fresher illustration, with which you are probably not familiar.

I have here a copy of the journal of the German Society of Engineers; in stricter translation, the newspaper of the German Union of Engineers, for September 5, 1903. You will find here a table of standard pipe and pipe threads adopted by this society at its last meeting in July. The table was adopted after conference with three other societies—the society representing pipe makers, and representing gas and water-works industries, and a society representing steam and hot-water fitting. So the table is a thoroughly well-matured scheme of pipe and pipe-thread manufacturers, and you will find in this table that the only dimension that anybody uses, in ordinary practice—the bore of pipe or pitch of thread—is given in English inches, and no other way.

You will find also, in parallel columns, the diameter at top or bottom, and of the thread, dimensions which nobody uses but the gauge maker. Those are given in millimeters. But the dimensions which the merchant and the purchaser and the mechanic use—that is to say, the bore of the pipe and pitch of the thread—are given in inches. These dimensions are given in English measurement. Likewise the mechanic, when fitting up his lathe to cut the thread, arranges to cut at 18 or 19 threads "per inch," and that is the dimension he uses. If you gentlemen were engineers you would have recognized that that standard is not a new one at all. It is little else than the Whitworth standard, which, by its fresh adoption, the German engineers acknowledge they can not change. In this they show they have learned a lesson.

In the early nineties there was a tremendous effort made through Europe to adopt metric bolt threads. The annoyance and incongruity of the use of English bolt threads with their metric dimension

were so great that a concerted and international effort was made to introduce metric threads. The societies of France and Germany finally brought in a system of screw threads which, however, has remained a system on paper only. It is not used by anybody to speak of. It is not even used in the German navy. The German navy uses English pitch bolts to-day, because if they use the metric bolts they can not get repairs when they are away from home.

Mr. COCKRAN. To what extent do you think that is attributable to the predominance of English iron and steel products during the time the transition of this system has taken place? In other words, given a certain commodity for bolts, when bolts are broken and machinery is to be renovated, would not the presence of so much more of English ware in use in the markets of the world have a great deal to do with it and largely contribute toward it?

Mr. HALSEY. Partially. The really essential thing is that the machine shops of this world are fitted out with machinery that will cut English threads, and will not cut metric threads.

Mr. COCKRAN. Then the present system of measurements in that department of mechanics would not, as it exists to-day, be expressed in metric terms?

Mr. HALSEY. Not regularly. Of course you could rig up a lathe——

Mr. COCKRAN. There could be no precise equivalent for the English measurements in the metrical terms?

Mr. HALSEY. No, except by the use of the long system of decimals. Of course, if you go to the German hardware store and buy this pipe and these bolts you will buy them by the kilogram and meter. In other words, as I said before, the compulsory laws of Germany have made the commercial unit metric, but the measurements remain in English.

There is, however, a still more important illustration than this in Germany, and that is the German building trades. A friend of mine, Mr. Howard Hess, of Philadelphia, who has lived many years in Germany, and laid out and built factories for them, and lived there for three years as chief engineer, tells me the German building trades use almost entirely the Rhenish inch and not the millimeter. You can ask how this can be in a country where the metric system has been compulsory for many years. It is due to the fact that in the purchases of soil the dimensions do not appear in the contract. You buy the land and building goes with it. What the builder of the house has to concern himself about in this matter is whether or not the purchaser will accept the house when it is done. It is perfectly obvious that the purchaser does not care whether the lumber or the cross sections of the timbers are in millimeters or inches. In spite of this the German mechanics continue to use the Rhenish inch.

I want to say regarding this law that is before you to-day that within its scope it is more compulsory than any general compulsory law can possibly be. I know perfectly well that this law is limited to the Government business; but within the scope of the Government business it is more compulsory than any general law can possibly be, because it provides that any customers shall be required to use the metric system. As I have shown you, in Germany the customer is not required to accept the metric system. He can accept anything

he wants. The consequence is the old system goes. But if this bill is passed, I tell you, you have required the German Government, in all its purchases, to acquire the metric system; and in that way you have made it more compulsory than they can do under a general compulsory law. There is a still more important illustration, and that is the textile industry. Mr. Dale is more competent to speak on that than I am; but it illustrates the argument I am on.

The CHAIRMAN. Perhaps, as it is about time for adjourning, we better not go into that, as it will take some time, I suppose.

Mr. HALSEY. There is one thing I want to say before I leave, a thing that will interest you gentlemen more than anything I have referred to. I refer to the attitude of the American people on this thing. The idea that the American people want this thing is the biggest mistake in the world, and I shall prove it to you before I get through.

Thereupon the committee adjourned until 1.30 p. m.

AFTERNOON SESSION.

The committee met at 1.30 o'clock p. m., Hon. James H. Southard in the chair.

STATEMENT OF FREDERICK A. HALSEY—Resumed.

Mr. HALSEY. Mr. Chairman and gentlemen, my thoughts come somewhat slowly, and I will say one word now that I had better have said this morning when Panama was mentioned, namely, that the Panama Canal, which was begun by the meter, will be completed by the yard. You will recognize that as one case where the drift is away from the metric system.

I was also told that I contradicted myself as to the extent to which the metric system is compulsory in Europe. The system is not compulsory, so far as I know, in Turkey, in Denmark, and, to the best of my knowledge and belief, in Russia. I think it is compulsory in most of the other countries, if not all.

Mr. GAINES. To what extent is it compulsory? With the Government only or with the people?

Mr. HALSEY. I mean with the people. When I speak of a compulsory law I mean a general compulsory law.

I had arrived at the point where I was to take up the question of the textile industry, which, of course, is to be dealt with in a detailed sense by Mr. Dale, because he is an expert on that subject and I am not. The case can be summed up, however, by saying that the metric system in the textile industry in Europe is a roaring farce. There is no lesser expression that will describe it. For the disclosure of these facts we are indebted to Mr. Dale. It is absolutely established that the silk fabrics that are sold across the counters of Paris by the meter are made in the mills of Lyons by the aune, the denier, and the French inch.

I have here a sample of the French inch, which I carry in my pocket as an interesting exhibit. This was bought for me in Berlin, where the purchaser told me that its duplicate can be purchased at any hardware store. It is a little folding scale, containing upon one edge the millimeter, upon another edge the English inch, upon

another edge the Rhenish inch, and upon the last edge the Paris inch. This Rhenish inch is used by the German building mechanics and the French inch is the one by which all French weavers set and gauge their looms, just as our weavers set and gauge their looms by our inch. This French inch is also used for other purposes, although that is the chief one we have discovered.

Regarding textile industries in Europe other than the silk industry, except in France, the English yard and pound are the basis of the entire cotton-mill industry throughout the civilized world.

The CHAIRMAN. The English yard differs from our yard, does it not?

Mr. HALSEY. I believe not—not appreciably. There may be a trifling difference, due to limitations of workmanship in reproduction, as there is a difference between our meter and the French meter; but there is no intentional difference.

The CHAIRMAN. I thought the difference between our yard and the English yard, while not so great, was somewhat like the difference there is between the English unit and the imperial unit.

Mr. HALSEY. No, sir; no difference of that amount. I believe one of the standard yards on deposit here in Washington is, within the limitations of workmanship, an accurate copy of the English yard. There is certainly no difference corresponding to that between the English and the American quart. Of course it is impossible to repeat any standard exactly.

In the cotton mill industry you may go wherever you like—to Germany, Russia, China, India, Japan, or back to this country—and you will find in the cotton mills nothing but the yard and the pound as the basis of the industry. There is no such example of uniformity in mill or factory measurements anywhere in the world as this use of the yard and the pound in the cotton industry, which, as I said before, is universal except in France, where they have a system of their own, which is only pseudometric, and that it is not metric is shown by the fact that they are trying to change it.

You will observe, however, that in this country and in England this uniformity extends to and connects the mill side with the commercial side. The yard and the pound in this country and England are not only the units of the mills, but they are the units of the merchants. Elsewhere we have diversity.

In Germany and in other metric countries, except France, the basis of the mill industry is the yard and pound, as it is here, but the merchants' units are the meter and the kilogram. In the woolen industry the case is still worse, because that industry is much older, and many of the old ells which were fastened in the industry centuries ago still persist in it, and this is true in France as in other countries. But here, again, we have the same uniformity between our mill units and commercial units; the yard and pound are common to both, whereas in Germany and other metric countries the commercial units and the mill units are different.

I have here a little German book which Mr. Dale handed me, "Calculator for Articles in the Textile Industry," which is simply a little handbook of calculations necessary to obtain the cost of certain fabrics.

Mr. GAINES. Who is the author?

Mr. HALSEY. A man named Frowein, a German. You gentlemen

were told that we should adopt this thing in order to save time in calculations. This book will show you how it works. You will find also in this book of ours, in my portion of it, a clipping from the German book I have referred to reproduced in facsimile and showing the actual methods used in Germany for calculating the cost of a piece of worsted cloth. The whole thing is in German, but Mr. Dale has given us an account of what is done in connection with that reproduction, and I hope you will listen to this if you do not listen to anything else:

The raw material is purchased by the *English pound*. The finished goods are sold by the *French meter*. The yarn counts are *English*, while the length and width of the finished goods are *metric*. The length of the yarn is expressed in *meters*, while the counts are *English*, based upon the *yard* and the *pound*. From this hodgepodge the weight of the yarn is indicated in *grams*, which is extended by another arithmetical somersault at a price given in marks per *English pound*, and to cap the climax the total length of the yarn in *meters* is reduced to *English yards* and then to *English skeins* of 560 yards each.

The system of yarn counting is a system for indicating the fineness of the yarn in terms of its weight and length. The yarn count includes the yard and pound if it is the English system, or the meter and kilometer if it is the French system. So in speaking of English yarn counts the expression conveys with it the fact that the yard and pound are used in the spinning of the yarn.

That, I think, will go alongside the letter of Mr. Channing, read this morning.

The CHAIRMAN. There is a statement of Mr. Dale, which appears in this book, describing the actual calculations that are made on a page of the book.

Mr. HALSEY. This is a small book, a handbook, but other books that the Germans have on this subject are large and handsome things. There is another facsimile reproduction of a table of figures, which Mr. Dale has given at page 186, and of which he says:

The Austrian weaver runs his eye down the columns headed "English yarn No." until he reaches a line, at the left of which is the set in threads per Vienna inch, and there he finds the weight in English pounds of the yarn he needs for 100 meters of cloth 100 centimeters wide. And this is also called "using the metric system."

Please observe that this first case which I have read—Mr. Dale's description of German calculations—includes nothin but English and metric units. The case has been purposely selected, so as to include none of the old ells. In other words, this calculation which I have read shows the effect of a mixture of units, the effect, in other words, due to the use of one set of commercial units and another set of factory units, and these results show precisely what would follow the adoption of the metric system in the textile mills of this country. The same mixture of units and the same difficulties in calculation would occur.

At the reading of my paper before the American society of mechanical engineers a year ago, which your chairman did us the honor to attend, he made the remark that he could not see anything about this matter for anyone to get excited about. You gentlemen, in recommending this bill, should you do so, are doing all in your power to introduce just the condition I have described here into the textile mills in this country. We get excited about the thing because we know what it means.

These calculations can be duplicated again and again. Mr. Dale has given many samples. We might fill out the book three times over, but the point to which I want to call your attention is that these books are imperative in the textile industry of metric Europe. They are samples of the transition technical literature which must be written in order to teach people how to handle a mixed system of units, and they are writing that transition technical literature in France to-day, with the system one hundred and ten years old. The case is so bad in France that they are again calling for compulsory laws to make people use the metric system in the textile mills. This is the most surprising thing in connection with the matter.

Now, please ask yourselves why it is that these old units persist in this way. If you will think a minute you will see that there are but two possible answers to that question. One is the change is so difficult to make that they can not make it. The other is that they prefer the old units. Of those two solutions the metric people can take their choice. I think you will recognize that those two answers absolutely exhaust the possibilities.

Now, gentlemen, I have shown you, I think, the pit of error into which these scientific gentlemen have fallen, and I want to consider for a moment why they have fallen into it.

I have explained that their initial assumption and their initial mistake is that this change is an easy one; but we still have to consider why they regard the change as easy. It is because in their work it is easy. Please remember that distinction. The scientific men believe this change to be easy because in scientific work it is easy. Few of us can see beyond our own horizon in these matters, and scientific men are subject to the limitations of human nature, like the rest of us. No part of this book is to me more satisfactory than a couple of chapters in which I have designated the difference between scientific and industrial weights and measures. To me the thing is like opening a book and spreading the thing in two halves—those who believe in this system and those who do not.

The scientific use of measurements consists of measuring things. The industrial use of measurements consists of making things to certain sizes. With surprisingly few exceptions the broad distinction exists that the men who favor this thing are measurers of things, while those who oppose it are makers of things. The change from the scientific man's standpoint—that is to say, from the measurer's standpoint—involves nothing but a change in measuring instruments. Here is this little scale I have shown you. With that scale I can measure things in millimeters and in three different inches by simply turning over the scale; but fancy the fitting out of a factory to manufacture things to all those four sets of sizes. You see here in a nutshell the difference between the measurers' side of this thing and the makers' side.

Should any of you gentlemen think, as some have stated, that we may keep our existing sizes and measure them in the new units, I can only say that is a technical question which I can scarcely discuss here to any extent. You will find it fully treated in this book, however. But I want to say, in the few words I can say on the subject, that it is simply impossible. I have shown why it is impossible, and I have shown, what is probably more to the point, the fact that nobody does it.

The CHAIRMAN. You are leaving the textile industry, are you?

Mr. HALSEY. I am leaving the textile industry; yes, sir.

The CHAIRMAN. Before you leave that I want to ask you a few questions. Mr. Crosby was before the committee.

Mr. HALSEY. Yes; I have read all of his testimony.

The CHAIRMAN. I do not know whether he stated it before the committee or not, but he told us that he was superintendent of the Lowell Textile School.

Mr. HALSEY. Yes; I believe that is his position.

The CHAIRMAN. He told us that their board of trustees controls a business amounting to many millions of dollars—my recollection is $60,000,000 or $70,000,000—and that they had found the weights and measures as they were used in the textile industry in this country so unsatisfactory that they had passed a resolution in their board providing for the adoption of the metric system in their factories. What do you know about that?

Mr. HALSEY. I do not know anything about it, except to say that they do not know the results of its adoption in Germany or they would not have passed the resolution.

The CHAIRMAN. He said they had done it after an investigation.

Mr. HALSEY. Well, they have not made any investigation worthy of the name or they would not have done it.

Mr. DALE. Excuse me, Mr. Chairman. I am familiar with the school, and they do not use the metric system in the school.

The CHAIRMAN. I think he stated that to us, and he said their board of directors had passed a resolution in favor of the use of the metric system not only in the school, but in the factories.

Mr. DALE. I think not.

The CHAIRMAN. In the school, at any rate; and so far as they can get at it they were going to use the metric system and teach it.

Mr. HALSEY. It is very easy for gentlemen who do not understand the results of the attempt to adopt this thing in the textile industry of Europe to think it would be a nice thing if we had it. They naturally assume that in Germany, France, and other places they really have it.

Mr. SHAFROTH. Here is Mr. Crosby's testimony, or statement, with which you are familiar, on page 19 of the hearing, and here is the letter of Mr. C. J. Woodbury to Mr. Samuel S. Dale, in which he says:

In reply to your inquiry of the 6th instant, I would say that the association never committed itself relative to the metric system of measuring yarns.

Mr. HALSEY. I have the original letter here in my collection.

Mr. SHAFROTH. Does that imply that they did commit themselves to the other thing?

Mr. HALSEY. Measuring or numbering yarn is the very foundation of textile measurements.

When I was stopped I was speaking of the impossibility of making measurements of existing sizes by millimeters; but more satisfactory, perhaps, to the average man is the fact that nobody does it. Two standards especially have been repeatedly mentioned as two which we would preserve by measuring with millimeters, and those two are bolt threads and pipes. It so happens that those two are the very things the Germans do not measure in that way. The Germans preserve the English bolt threads and English pipe, but they measure

them in inches, not millimeters. In other words, the two English standards which the Germans have preserved have carried the inch with them. We have to-day a thousand standardized things where the Germans had one when they adopted this thing thirty years ago, and just as those English standards in Germany have required the preservation of the inch to measure them; and so every standard we have requires the preservation of the inch to measure it. Nothing in the world is better demonstrated than that.

Another illustration of the same thing, and a larger one, is the case of the German building trades. Why do not those trades use this plan and so retire their inches? The same question applies to these textile standards. Why is it they keep the old units to measure old standards? They do it because they can not do otherwise.

The CHAIRMAN. Why can they not do otherwise?

Mr. HALSEY. You are opening up a very large subject. I am telling you the facts, the reasons for which I have given in this book. The reason is that this plan leads to a list of sizes that nobody can remember. For example, if a man wants to call for a bolt by metric measure he must know the metric size.

The CHAIRMAN. You are confusing the two systems. I am supposing that one system was used.

Mr. HALSEY. You have not got the point. I am talking about an idea which these people advance, which is the last ditch of the metric argument. I am speaking to a suggestion which they make, that we preserve our existing standards by measuring them in millimeters.

The CHAIRMAN. Did you ever work in the metric system?

Mr. HALSEY. Not in construction, but I have used it enough to become entirely familiar with it.

The CHAIRMAN. We had Mr. Linnard before the committee last year, and, as I understand it, he was sent for four years over to the old country to work in a navy-yard over there, and he told us he used the metric system over there. He said he was perfectly familiar with both systems, and that so far as facility of working in one system or the other was concerned there was no difference; that their men worked in the metric system over there just as easy as ours worked in our system here; that so far as that part of it was concerned he did not see any difference. Now, he was a practical mechanic working over there for four years in the metric system, as he told us. How do you account for such statements as that?

Mr. HALSEY. Mr. Linnard is violently opposed to this thing.

The CHAIRMAN. I said that he was opposed to it, and I mentioned that he was opposed to it in connection with his statement, to call the attention of the committee to the fact that he would not make any statement in its favor that perhaps was not true.

Mr. HALSEY. Perhaps I did not catch your question.

The CHAIRMAN. I understand you to say that it is impossible to use the metric units in mechanical work.

Mr. HALSEY. You entirely misunderstand me, because I have unwittingly entered upon the technical phase of the subject. I said it is impossible to measure our existing inch sizes—inch and a quarter, inch and a half, and so on—in metric units.

The CHAIRMAN. You mean that we have no exact sizes in metric units corresponding to existing sizes in our own system.

Mr. HALSEY. That is part of it, and only part. The whole story

is that when you take that in, when you take the set of sizes that are used everywhere, from making bolts and lumber to building steamships, and attempt to preserve them in metric units you get such a list of figures that no man on earth can remember them.

The CHAIRMAN. When the system became general there would be no necessity for translating, would there?

Mr. HALSEY. Pardon me, Mr. Chairman, but you do not know what you are saying. You are leading into the technical side of this question, which I am trying to avoid, for obvious reasons. This phase of the subject can not be intelligently discussed except before a technical audience.

The CHAIRMAN. You are trying to illustrate the confusion which would result in the transition period.

Mr. HALSEY. When I go to intelligent metric advocates in the shops, of which there are a few, I find they appreciate the importance of preserving our standards of pipe and bolts and a thousand other things just as well as I do. They say those things are to be preserved by keeping them as they are and by measuring them in metric units. That is the irreducible minimum of the metric case, as applied to the machine shop. It is the last ditch into which they retreat, and it is the thing which has caught more good men than all the other fallacies together. It seems so plausible that lots of good men have fallen into it.

There is no intelligent man in the machine shops, whether he believes in this system or not, who will for one minute contemplate the retirement of our standards for the sake of this system. They say, as we do, that those things must be preserved. We say they can only be preserved by preserving the inch. They say they can be preserved by measuring them in millimeters, and what I am speaking to now is the impossibility of doing what they say can be done; that is, the impossibility of measuring inch sizes by millimeter equivalents. I have proven it by showing that nobody does it, just as I said a moment ago. Pipe and bolts are both measured and made to English units in Germany. The two very things that we are told we will measure in millimeters are the two very things that are measured in inches in Germany. In addition to that I have given the reasons why they do not do it—simply, as I have said, because it leads to a list of figures that nobody can remember. You might as well try to memorize a table of logarithms.

The CHAIRMAN. How many systems of screw threads are there now?

Mr. HALSEY. There are a good many. There is one standard system and a lot of miscellaneous things.

The CHAIRMAN. Are there not several systems that are called standard?

Mr. HALSEY. There is only one that is really standard.

Mr. SHAFROTH. Do not the screw threads of America correspond with the English system?

Mr. HALSEY. No; they do not. We are about the only country in the world that does not use the English screw-thread system.

The CHAIRMAN. We had a good deal said here about twist drills. I saw the manufacturer of twist drills here last winter, and he told me they made twist drills in metric sizes and had been doing so for some time.

Mr. HALSEY. Undoubtedly they make them, because there is some demand for them. They sell them abroad.

Now, gentlemen, what shall I say more? I might talk to you for and hour on any one of a dozen phases of this thing. I might speak of the export-trade argument, but I have discussed that in a chapter by itself, and I think after you read that chapter you will find there is not enough left of the export-trade argument to find the fragments. I might talk of the inaccuracy of the meter, and perhaps I ought to, for it is the funny side of the matter.

Mr. GAINES. I should like to hear how it is going to affect our export trade. That is a big thing with us.

Mr. HALSEY. I think if those of you gentlemen who are disposed to lie awake nights on that subject will read my chapter in regard to it you need not lie awake nights any more. There has been no demand whatever for this thing from our buyers abroad. Only the other day I was told in Mr. Cushing's office of a conversation with a representative of Schucart & Schutte, of Berlin, who are the leading machinery merchants of Germany, and through whom more American machinery has probably gone to Germany than through any other source. This gentleman said in Mr. Cushing's office that the adoption of the metric system by the United States would not enable them to sell another dollar's worth of American machinery there, and if you will read my chapter on that subject you will see why it is so.

Mr. GAINES. Does not the sending of the immense machinery we are sending all over the world now tend to educate the people into our pounds and our inches?

Mr. HALSEY. Yes; but it is not that. Nobody cares about the sizes to which the parts of machinery are made provided they do their work. Look at the way automobiles come over here from France and are sold. Did you ever hear anybody ask whether they are made to English units or not? Who cares whether a certain shaft in a machine he has bought is an inch in diameter or 25 millimeters in diameter?

Mr. GAINES. A Yankee can make anything.

Mr. HALSEY. Irrespective of that, the thing which sells a machine is its quality, its price, and the time of delivery.

The CHAIRMAN. The French machines are made on the metric system.

Mr. HALSEY. Yes; except for the screw threads. We buy several hundred millions of dollars worth of manufactured goods from metric countries every year—I do not know the exact number of millions—but an immense quantity of goods comes here every year from metric countries, and they all sell without question regarding the units of measurement to which they are made.

Mr. GAINES. When we repair them do we repair them by the metric system or by our system?

Mr. HALSEY. We have to repair them as they are. The question of repairs, except for a few things, is entirely independent of the system of units used. With the exception of screw threads and cut gears, there is practically no repair that can not be made in this country just as well to metric as to English measurements if they are required. Likewise abroad they can repair our things just as well as we can. You understand, of course, that repair operations are entirely different from manufacturing operations.

Mr. SHAFROTH. That demonstrates also, does it not, that if we made our things under the metric system we would be at no disadvantage in selling them?

Mr. HALSEY. That is true, but the point is that there is no demand for it.

Now, about the inaccuracy of the meter. Consider the infinite effort with which that meter was established. The survey occupied seven years' time, and was prosecuted at the risk of life, limb, and liberty. One man was imprisoned and two lost their lives, not from violence, but from exposure. The Spaniards assumed those men to be spies, or perhaps engineers of an invading army of France, and they led a very strenuous life. After that work was done the calculations were almost equally laborious. There was no end of effort to check that meter and establish it to be accurate, and now they tell us it is all of no use. They tell us that all that infinite effort was for nothing; that the meter might just as well have been guessed at. Does it not strike you as a pretty severe comment upon the good sense of those who originated the system?

Mr. SHAFROTH. How much is it inaccurate?

Mr. HALSEY. About one two-hundredth part of an inch.

Mr. SHAFROTH. Is it not a fact that it is the exact measurement if the meridian would go through the city of New York instead of Paris?

Mr. HALSEY. I have seen that stated, but I do not know. The reason for the measurement of the meter is not known by one metric advocate in a hundred.

Mr. SHAFROTH. Was not the reason that the one ten-millionth part of the quadrant was adopted so as to have easy navigation in the area of the Great Circle, and by which you could multiply immediately according to the log, that it would go the distance and the course you were sailing over?

Mr. HALSEY. You are exactly correct, and for that very purpose for which it was expressly intended it is a flat failure. The French navy and mercantile marine measure all sea distances by the English mile and all speeds by the English knot, just as we do.

Mr. SHAFROTH. You do not mean to say their maps are not founded on the metric system?

Mr. HALSEY. I do not know about the maps, but I know when they measure distances and speeds it is done by the English mile and the English knot. I have a clipping from a French paper in regard to some of the new French cruisers, in which the steaming radius is given in miles and the speed in knots.

Mr. SHAFROTH. I think you will find that the depth of harbors and all that kind of thing are measured by millimeters.

Mr. HALSEY. No doubt their geodetic surveys and coast surveys are made in that way, but I am talking about the practice in measuring distances at sea.

Again, I might talk of the abandoned portions of the metric system, for many do not know that what we call the metric system is nothing but a fragment, nothing but a chain from which some of the essential links are missing.

I might talk of the supposed confusion of our weights and measures and show you, what is a fact, that there is less confusion in our

weights and measures than in those of any other country under the sun.

Mr. SHAFROTH. Has anyone complained of the confusion?

Mr. HALSEY. I do not know of any except the advocates of the metric system.

I might argue about the superiority of this thing, and show that it has none. I might examine into the metric argument in detail for uniformity, simplicity, saving time in calculations, and saving time of the school life of children, and show you that they are nullified, simply because when we come to handle two systems of units we introduce conversions between the two systems that neutralize the saving many times over, but I will pass these things by.

There remains, therefore, but one thing more, namely, what are you going to do about it? In this connection I want to show that the metric advocates are entitled to nothing. That there is any demand for this thing sufficient to justify the attention of Congress or of this committee for a single hour is the biggest mistake of all. We all know how these things are done. Some enthusiastic gentlemen organize a society and conduct an aggressive campaign. They are a great deal in evidence, get out their vote whenever needed, and make a great deal of noise. There never was a better illustration of the value of a little organization than the impression these people have been able to make. It is simply monstrous and unthinkable that these enthusiasts simply by persistence should force this thing on the manufacturers, who are opposed to it and who have the problems to face and the bills to pay.

The CHAIRMAN. You do not mean to say that all the manufacturers are opposed to it?

Mr. HALSEY. I mean the large majority of them are. The manufacturers of this country did not take this matter seriously until your report was rendered two years ago. Many do not take it seriously now. Your report two years ago, however, has led to some voting on the subject, more than you are probably aware of, and these votes you will find in the appendix of our book. They are collected together there for the first time, and some of them, I believe, appear there for the first time. You will find there the votes of eleven different societies, of which ten are national in their scope. Of these, of course, the most important is the American Manufacturers' Association, in whose behalf I am here to-day, and which is, I believe, the largest manufacturers' association in the world. Am I correct about that, Mr. Cushing?

Mr. CUSHING. That is right.

Mr. HALSEY. You will find the vote of the American Society of Mechanical Engineers and that of the Society of Naval Architects and Marine Engineers, and let me add that the existing chief constructor and the existing chief engineer of the Navy and the predecessors of both of them are opposed to it.

Mr. GAINES. Was not a resolution passed some time back, possibly during the time of Mr. Secretary Evarts, in which the Government officers were called upon to give an opinion on this, and did not a large majority of them condemn it outright?

Mr. HALSEY. I do not know, I am sure.

You will find also the vote of the Heating and Ventilating Engineers, the Railway Master Mechanics' Association, the Master Car

Builders' Association, the Metal Trades Association, the Machine Tool Builders' Association, the Engine Builders' Association, the Furniture Association of America, the Providence Society of Mechanical Engineers, and, so far as I know, in the meantime no other society has voted the other way.

The appendix of your report of two years ago gives a list of associations that are supposed to have indorsed this thing. I believe the word used is "approved." I am glad I do not know who prepared that appendix, as my statements regarding that list will be severe, and I am glad that they must be impersonal. In that list you will find the Association of American Steel Manufacturers. I have here a letter from the secretary of the Association of American Steel Manufacturers, Mr. Albert Ladd Colby, dated August 1, 1903, in which he says:

At a meeting of this association, held in Pittsburg on April 17, 1896, the following resolution was adopted:

"*Resolved*, That this association indorses House of Representatives bill No. 7251, and requests that the individual members of the association correspond with their Representatives and Senators urging its passage."

Later on, namely at the meeting held in April, 1902, in response to a request for action on bill then pending in Congress in reference to the metric system, the association decided that as the matter was then in the hands of the National Manufacturers' Association, that it would be better for this association to take no action on it as a body.

Mr. SHAFROTH. That shows that in 1896 they did indorse it, and in 1902 they were divided upon it.

Mr. HALSEY. They declined to do anything at the later date.

Mr. GAINES. What have the manufacturers done?

Mr. HALSEY. They went against it two years ago by a vote of three to one, and now they are engaged in taking another vote. The association has grown very rapidly.

Mr. GAINES. Is that the association the gentleman from New York was talking about a little while ago?

Mr. HALSEY. The association Mr. Cushing spoke of; yes.

In this same list I find the New England Cotton Manufacturers' Association. I have here a letter from the secretary of that association, Mr. C. J. H. Woodbury, dated January 7, 1903, reading as follows:

In reply to your inquiry of the 6th instant, I would say that the association never committed itself relative to the system of measuring yarns.

And I hope you will remember distinctly that the system of measuring yarns is the basis of all textile mill measurements.

In that list is also the American Society of Civil Engineers. I have a letter from the secretary of that association, Mr. Charles Warren Hunt, dated January 6, 1904, in which he says:

Answering yours of the 4th instant, so far as I know this society has never taken formal action in indorsement of the metric system.

I also find here the National Association of Builders. I have a letter from the secretary of that association, dated January 11, 1904, as follows:

Your favor of January 9 was duly received. In response to your inquiry I beg to say that the National Association of Builders has never taken any action favoring the metric system.

Mr. GAINES. Who said it had?

Mr. HALSEY. It appears in the appendix of the report of your hearings of two years ago. Who prepared the appendix, I say, I do not know.

Mr. GAINES. Where does it appear in that?

Mr. HALSEY. I can give you the page in a moment. It is page 203. You will also find in that list the Civil Engineers' Club, of Cleveland, and I have a letter from the Secretary of that society, Mr. Joe C. Beardsley, dated January 12, 1904, in which he says:

Answering your favor of 8th instant, I am unable to find that our club has ever adopted resolutions indorsing the metric system.

I have not followed up all the societies in that list. There are many there that have nothing to do with factory or commercial measurements, and I regard their indorsement as of no significance.

The CHAIRMAN. Did you write to each one of these?

Mr. HALSEY. Not to all of them. I wrote to those from whom I have letters here.

The CHAIRMAN. Did you not write to others also?

Mr. HALSEY. I wrote to one more, the Boston Society of Civil Engineers, which it appears did indorse the system in 1877. I wrote to one more society, from which I have had no answer.

[Added since the hearing: The society referred to in the last paragraph as having made no reply is the American Institute of Architects, which also appears in the list referred to. I now have a letter from the Secretary, Mr. Glenn Brown, dated January 23, 1904, reading as follows:

The American Institute of Architects has discussed quite frequently the merits of the metric system, but the Institute has never yet formally approved the adoption of that system.]

Mr. SHAFROTH. You did not write to the others named here?

Mr. HALSEY. No, I did not. I regarded them as having no importance.

Mr. GAINES. Will you write to them, and send the answers here?

Mr. HALSEY. I do not know whether I can find the addresses of all of them.

Mr. GAINES. I wish you would do so, and send the answers to the chairman of the committee.

Mr. HALSEY. As I say, there are societies here which have nothing to do with factory or commercial measurements. They regard themselves as highly scientific, and I thought it probable that they do favor the system, but as I regard their opinions as of no significance, I did not write them.

I will not dwell on the manner in which this metric case has been made up. That was not my primary object in bringing these things here, because these letters teach us a much more important lesson than appears on the surface. I have told you of the action of the American Steel Association in refusing two years ago to confirm their previous indorsement.

The CHAIRMAN. You do not mean to say that the statement that the American Steel Association had indorsed it is incorrect?

Mr. HALSEY. No; but I mean to say that they declined to repeat the indorsement as regards this present bill.

The CHAIRMAN. But their original indorsement, until they take some other action, stands?

Mr. HALSEY. I would say it is now a very qualified indorsement.

The CHAIRMAN. You would not say that indorsement would affect this list? The last letter you read says the writer has not been able to find that they had adopted resolutions indorsing the metric system.

Mr. HALSEY. He is the secretary of the society. He has the records before him.

The CHAIRMAN. Anything we put in that appendix was based upon something indicating that it had been done. There was no attempt to falsify that.

Mr. HALSEY. I am not assuming that anybody is falsifying here. It is simply the case of the reformer all over again. The reformer thinks he is at liberty not to be too awfully particular when he is trying to do the world good.

The CHAIRMAN. Take such men as Mr. Elihu Thomson, Mr. Westinghouse, men who are at the head of large manufacturing institutions of the country, and Mr. Whitman, at the head of a large woolen concern. Would you characterize those men as reformers?

Mr. HALSEY. I think the average metric advocate is a typical reformer. I do not know anything about those men, and I have nothing but respect for reformers, but what I mean to say is it is the easiest thing in the world to hear something said and then repeat it.

The CHAIRMAN. Is Doctor Kennelly a reformer?

Mr. HALSEY. I have nothing against Doctor Kennelly. I simply mean to say that that list has statements in it that are not true.

The CHAIRMAN. So far as the list is concerned, it was taken by the stenographer. He may have made mistakes, of course, but we have relied upon his notes for what appears in this book.

Mr. HALSEY. I do not know where the list came from, but you gentlemen have had pretended facts like that presented you to show the supposed strength of this thing and I am engaged in showing you that it has no strength; and my starting point is that five of those indorsements are untrue and two more of them are qualified.

The CHAIRMAN. You would not call such a man as Mr. Christie a reformer, would you?

Mr. HALSEY. No; I have great respect for Mr. Christie.

The CHAIRMAN. And there are a great many others that appear here.

Mr. HALSEY. Yes; that is very true. They did not make up the list, probably.

The CHAIRMAN. You have no doubt about the correctness of this statement as it appears in our hearings, have you?

Mr. HALSEY. Mr. Christie's statements?

The CHAIRMAN. Yes.

Mr. HALSEY. So far as his statements of fact are concerned, of course not. I am dealing with this list, not with Mr. Christie's statement.

The CHAIRMAN. As I understand it, you characterize the people who advocate the adoption of the metric system as reformers?

Mr. HALSEY. Many of them are.

The CHAIRMAN. Oh!

Mr. HALSEY. The fact that there statements are not true is not

the chief fact that I wish to bring out. That is not my primary motive in bringing these letters here.

Mr. GAINES. Do you know Mr. George H. Colles, 408 Union Building, Milwaukee, Wis.?

Mr. HALSEY. Yes, sir.

Mr. GAINES. He represents the National Association of Manufacturers. Is he opposed to the metric system?

Mr. HALSEY. He is strongly opposed to it. He read a paper some years ago on it.

The point I want to make is this: I am not here to accuse these people of mendacity. I am pointing out, in the first place, that there are mistakes; that the things stated there as facts are not facts; but I have a much more important thing than that to say. You have heard the letter I read from the American Steel Association saying that their previous indorsement had not been repeated. With that exception these people have no organization representing manufacturers of mechanical products. I say mechanical products because the chemical associations in that list I have not followed up; but as regards the mechanical manufacturers they have no organization representing their interests.

The CHAIRMAN. Whom do you represent here?

Mr. HALSEY. The National Association of Manufacturers.

The CHAIRMAN. In what way?

Mr. HALSEY. Simply as their spokesman.

The CHAIRMAN. You say as their spokesman. Do you mean by resolution passed by the society?

Mr. CUSHING. Yes, sir; Mr. Halsey is our authorized representative here. There are others whom we would like the committee to hear if they will permit it.

The CHAIRMAN. The society designated a number of people to come here, did it?

Mr. CUSHING. No, sir; the number was not designated.

The CHAIRMAN. What makes me ask is this: I have letters from manufacturers belonging to the association advocating the system, and I did not know whether those opposing it had simply designated men to speak for the association or in what form their authorization came.

Mr. CUSHING. The national association is doing two things in regard to this—having a ballot of its members to see how they stand on these questions, and opposing the measure by presenting these facts.

The CHAIRMAN. The association has designated men to oppose it or to favor it or to express their own opinion in reference to it?

Mr. CUSHING. As I have just stated, it is having a ballot of its members. The ballot shows the membership is opposed to the proposition, three or four to one. The experts and others who are familiar with the practical side of the matter, and who appear here, of course make their own statements, but their interest is common with ours, and we would be glad to have them get the opportunity to be heard.

The CHAIRMAN. But in what form did the authorization come?

Mr. CUSHING. By resolution of the executive committee of the association.

The CHAIRMAN. Designating any particular people to appear?

Mr. CUSHING. No, sir; leaving the matter with the secretary to

present our side of the case. That is the formal way in which such things are done.

The CHAIRMAN. And the secretary designates the men who are to appear?

Mr. CUSHING. He perhaps encourages several of them to appear with him. Then he presents the association's side of the case as strongly as he can, you may be sure.

The CHAIRMAN. Then the secretary designates men opposing it to appear, and only those opposing it?

Mr. CUSHING. We should make no objection if any of our members wish to come who favor the bill.

The CHAIRMAN. It is not that. I am just trying to get at whether the association designates only men who oppose it to appear or whether they designate men to represent both sides of the question.

Mr. CUSHING. The association is opposed to the measure and is trying to make out as good a case as it can against it.

The CHAIRMAN. I think I understand the situation.

Mr. GAINES. Do you know Mr. George N. Goodwin, of Nashville, the cotton manufacturer down there?

Mr. CUSHING. Yes, sir.

Mr. GAINES. He is opposed to it and has written me a letter, Mr. Chairman.

Mr. SHAFROTH. What do you say as to the statement of Mr. Pawling, who was before the committee last year, that he had received twenty-one letter from manufacturers, twenty of which indorsed the use and adoption of the metric system?

Mr. HALSEY. I do not know where he got his list. I expect he told the truth, of course, but I do not know where he got the list unless it was picked out for him.

Mr. SHAFROTH. He reads extracts from a number of them. One is Alvan, Clark & Co., of Cambridge, Mass.; another is F. F. Nickel; another is the Engineers and Architects' Club, Louisville, Ky.; the American Waltham Watch Company, Waltham, Mass.; Professor Goodspeed, of the University of Pennsylvania; Williams, Brown & Earle, of Philadelphia; J. A. Fay & Eagan Company, Cincinnati; the Bullock Electric Manufacturing Company, Cincinnati, Ohio; Gould & Eberhardt; the Pennsylvania Railroad Company, department of maintenance and way; and the Stanley Electric Manufacturing Company, Pittsfield, Mass. You did not write to those manufacturers?

Mr. HALSEY. No, sir.

Mr. GAINES. Did he read all of the letters he received?

Mr. SHAFROTH. Yes; twenty-one he had received at the time he testified.

Mr. GAINES. Did he give a part of the letter, excerpts from the letter, or the whole letter?

The CHAIRMAN. He had the letters here. I do not know whether they are here now or not.

Mr. GAINES. They are, then, parts of the letters which he received and not all of all the letters he received?

The CHAIRMAN. In some instances he gave probably the whole letter, but in most instances it is probable he gave part. The signature

is omitted and the beginning of the letter is omitted. Whether it contains all or not I do not know.

Mr. HALSEY. Now, gentlemen, the point I want to make is that with the exception of this American Steel Association they had no association representing manufacturers of mechanical products.

Mr. BROWN. That is not the American Iron and Steel Association that is referred to.

Mr. HALSEY. No, sir.

Mr. BROWN. That is a very different association altogether. The American Steel and Iron Association is a very different institution.

Mr. HALSEY. I understand. Now, observe, we have the National Association of Manufacturers, the Machine Tool Builders' Association, the Engine Builders' Association, the Metal Trades' Association, and the Furniture Association. The Furniture Association, I ought to say, is composed of both manufacturers and dealers, but the other associations are purely manufacturers' associations. In this list in your appendix you will also find the American Institute of Electrical Engineers, and if you will turn back to page 194 of your report you will find that the Institute of Electrical Engineers, as a body, never took any action whatever. They never even appointed a special committee. On the contrary, an existing committee took it upon itself to bring in certain resolutions, which they brought in not to the body of the society, but to the board of directors.

The CHAIRMAN. You include in that list the American Society of Mechanical Engineers?

Mr. HALSEY. I am speaking of the electrical engineers.

The CHAIRMAN. I say, did you include in that list the American Society of Electrical Engineers?

Mr. HALSEY. I have not read them yet as being among the American manufacturers. I shall come to it in a minute.

The CHAIRMAN. I want to say, Mr. Halsey, I would like to get away about half past 3.

Mr. HALSEY. I am very nearly through, Mr. Chairman. If you will turn to page 194 you will find, as I say, that an existing committee took it upon itself to bring in this report, and that they brought it in to the board of directors, and that the board of directors, a quorum being present, as we are told, indorsed that resolution, and here you will find that same old chestnut:

Whereas these advantages have already been demonstrated by the universal adoption and entirely successful use of the metric system in all civilized countries except Great Britain and the United States.

So that, you see, the indorsement of the Institute of Electrical Engineers is the indorsement of the board of directors only. With that exception they have no national engineering organization, while we have the Mechanical Engineers, the Naval Architects and Marine Engineers, and the Heating and Ventilating Engineers.

The CHAIRMAN. You have no doubt that the electrical engineers are almost a unit, have you?

Mr. HALSEY. Mr. Cushing's vote includes the vote of electrical manufacturers. I saw those that had come in last Saturday. They stood 6 for and 9 against.

The CHAIRMAN. I am speaking of the electrical engineers.

Mr. HALSEY. I presume you will find them in favor of it. I do not

know; but with that qualified exception, they have no national association of engineers, and we have three. In addition to that we have these two railroad associations; and I wish I could make you understand the importance of those associations. I mean the Master Mechanics and the Master Car Builders. They have done more to introduce uniformity of measurements in this country than all other influences combined. It comes about that, simply through the enormous demand of the railroad requirements, when these associations resolve that the railroads shall buy nothing but a certain standard, that immense demand puts the standard upon its feet, and the first thing you know the standard thing becomes a staple thing.

I have given you the votes of those having in charge the technical and business sides of our manufacturing industries. I have given you the votes of those having in charge the mechanical equipment of our railroads. These are the men whose message I bring to you today. How much importance as against them you shall ascribe to the American Microscopical Society or the Photographic Society or the American Meteorological Society is for you to say, but I do not think you will give them very much. To me as striking a thing as the names of these societies is the way they have passed their resolutions. With a single exception the smallest majority on this bill is 3 to 1 against the system, and the majorities run from that up to substantial unanimity.

Another thing that is quite as remarkable is the nature of the resolutions themselves. You will find in these resolutions no glittering generalities. You will find they do not condemn the metric system, that they do not condemn compulsory laws in general terms, but, on the contrary, in precise and specific terms they condemn this bill.

I thank you for your attention, gentlemen.

The CHAIRMAN. I would like to ask you one or two questions, Mr. Halsey. I understood you to say in your remarks that there was no tendency toward the adoption of the metric system. We are told that in 1895, I think, a select committee appointed by Parliament to make an investigation and report as to the advisability of the adoption of this system reported 16 to 1 in favor of its compulsory adoption in Great Britain. We are also told that the colonial premiers, at a meeting held in London, I think, last year, passed a resolution, after some consideration, and unanimously voted in favor of a resolution providing for the compulsory adoption of the metric system there; and I see by a recent report that at a meeting of the chambers of commerce of the British Empire, held, I think, in Toronto, last summer, or perhaps in August, by an almost unanimous vote they declared in favor of the compulsory adoption of the metric system for the British Empire. It is said that at that meeting about 600 chambers of commerce were represented. I do not know that I fully understand your meaning when you say there is no drift of sentiment to the adoption of the metric system.

Mr. HALSEY. What the situation is in England I do not know, but it is partly explained by the fact that she is concerned over her commercial supremacy and thinks something must be done.

Mr. SHAFROTH. Do you know of a single foreign country considering the adoption of the English system or the American system?

Mr. HALSEY. I do not know of any.

Mr. SHAFROTH. Do you know of any board or commercial body in

any foreign country that is advocating the adoption of the English or the American system?

Mr. HALSEY. I do not know of any.

Mr. SHAFROTH. Do you not think the trend is toward getting a uniform system through the world, if possible?

Mr. HALSEY. I think the superficial trend is that way, but I think the actual trend is not. As I have tried to explain, the depth of penetration of this thing is microscopical. They simply succeed in changing the commercial units and leaving the factory units as they were. The factory side of this thing is the big side; the commercial side is the small side. Speaking of the difficulty of making the change, the commercial change is comparatively easy. The factory side is where the great difficulty arises. There is more measuring done to-day in Philadelphia than in all the South American countries, and the system of measurement of all South America could be changed more easily than that of Philadelphia. You talk about the trend. The amount of manufacturing done to-day under the English system is immensely more than under the metric system. Likewise the commerce of the world is done that way.

The CHAIRMAN. On page 207 of our printed hearings the names of 259 members of Parliament are given. That is almost a majority, as I understand it, and it is stated that these members have signified in writing their willingness to vote to make the metric system compulsory in Great Britain.

Mr. GAINES. Have they done so, Mr. Chairman?

The CHAIRMAN. They have signified their willingness in writing.

Mr. GAINES. But they were in session when I was over there this summer, and they did not talk metric system. They have the metric system in Canada, but it is not used, as is shown in the testimony of Professor Klotz, on page 148.

Mr. HALSEY. As regards England, I subscribe to one of the clipping bureaus for all metric clippings throughout the world. I got a clipping the other day from England saying that a bill was to be introduced in the House of Lords in the coming session of Parliament. This was given in the words of the lord who was to introduce it; I have forgotten his name. He said distinctly that he did not expect to get the bill passed, but he expected it to excite discussion, and that is all he expected.

Mr. GAINES. Will you put that clipping into the hearing?

Mr. HALSEY. I do not know whether I have saved it or not. I get them in large numbers. Some I save and some I do not.

Mr. GAINES. Do you know of any single bill introduced in the parliament of a foreign country which proposes to adopt the English or the American system?

Mr. HALSEY. I do not. The point is, gentlemen, we have the very thing for which the metric system has been adopted in other countries. They have done it in the search for uniformity, and uniformity we have. We have a greater degree of uniformity than any country in the world. I do not care what is told you to the contrary. It is not so. You must go to a metric country for confusion and come here for uniformity.

Mr. GAINES. Mr. Chairman, there is a gentleman here from Boston, Mr. Dale, who is a textile representative.

The CHAIRMAN. We will hear Mr. Dale.

STATEMENT OF S. S. DALE, OF BOSTON, MASS.

Mr. DALE. Mr. Chairman and gentlemen, I want to speak on this question from a textile standpoint, as I was a textile workman for twenty-three years, and for the last four years have been studying the metric system as applied to textile manufacturing.

In considering the introduction of the metric system into the textile industry three questions naturally present themselves:

1. What is the system we have now?
2. What is the new one we are asked to accept?
3. Can we change from one to the other without serious difficulty?

Starting with the first question, we now have in the textile industry two units of length, the yard and inch, and four of weight, the pound, ounce, dram, and grain. Each of these units is used for a distinct purpose for which it is well adapted, and they conflict in no way with each other. The units of length and weight are respectively commensurable, and have the additional advantage of names that are distinct in sound and appearance.

Mr. SHAFROTH. Do you mean to say that the weight of silk and the weight of cotton goods are the same?

Mr. DALE. The only units for expressing the weight are included in the four I have mentioned.

Mr. SHAFROTH. Is not the unit in silk entirely different from the unit in cotton?

Mr. DALE. We use the dram in silk, and that is included in the list.

Mr. SHAFROTH. Then there are four standards?

Mr. DALE. Four standards or units of weight.

In manufacturing textile goods there are very few measurements of area, and none whatever of cubic capacity. There is one characteristic feature, however, of textile weights and measures which distinguishes them from the standards of probably every other industry. It is the extensive use of ratios between weight and length. It is not only necessary to measure and to weigh textile materials by the units of length and weight already named, but in nearly every one of the many complicated processes of textile manufacturing it is necessary to measure the intangible ratios between the weight and the length of textile products.

The strands of textile materials vary from a few yards to a thousand miles per pound, and the varying ratios between the weight and length are expressed by counts or numbers, which indicate the number of lengths, called hanks, per pound of spun yarn, or the weight of a fixed length of reeled silk. Four lengths are used in the United States for spun yarn and one for silk; these five are the standards for the United States and the British Empire, including a population of 475,000,000 people. We have for spun yarn the cotton length of 840, the worsted of 560, the linen of 300, and the woolen of 1,600 yards, and for reeled silk the length of 1,000 yards. Each of these systems of yarn numbering, with one unimportant exception, is confined to one kind of textile material. The woolen standard (100 yards per ounce) and the silk standard (1,000 yards) are decimal. All these Anglo-American systems of yarn numbering are based on the English yard-pound.

The English yarn system is the world's standard for linen. The

840-yard English system is the standard for cotton throughout the world, with the exception of France. In France they do not use the metric ratio. The only other exception is found in Spain, where an attempt to match the English standard has resulted in a system based on Spanish units and differing but 3 per cent from the English. This sample card, recently issued in Germany, shows present German practice. It gives samples of cotton yarn with size numbers, and the note attached reads: "The system of numbering is the English." It is published in Germany by Otto Holtzhausen, of Bayreuth, for sale to German merchants and manufacturers.

There are 105,000,000 cotton spindles in the whole world, and of this number 68,000,000, or nearly two-thirds, are in England and the United States. Taking into consideration the use of the Anglo-American standards in other countries, it is a conservative estimate that three-fourths of the textile work of the world to-day is done by the English standards of weight and measure.

A MEMBER. What is the other fourth done by?

Mr. DALE. A mixture of standards, including the old standards of France, the different States of Germany, Austria, Italy, Spain, etc.

In 1901 the exports of cotton goods from Great Britain, India, and the United States amounted to $425,000,000—all manufactured by the English standards. The exports of cotton goods from France and Germany in the same year were valued at $95,000,000, and in the manufacture of these French and German goods the metric system was used but very little. The English system is an international textile standard, and, in fact, the only one. The German Government is forced to use it in assessing duties on imports. In February, 1902, you gave a hearing on the bill to introduce the metric system into the Government work of the United States, preliminary to its general introduction throughout the country. Twenty weeks later a committee of the German Reichstag gave a hearing on the proposition to dispense with the English and use the metric system for assessing duties on cotton yarn imported into Germany. At that hearing Herr Münch-Ferber, of Hof, Bavaria, a member of the Reichstag and a textile manufacturer, denounced the proposition and declared it would throw the German textile industry into "ungodly disorder" (heillose Verwirrung). The German proposition was defeated and the English system remains the official German textile standard. Other evidence as to the use of the English system in foreign trade will be found on this card.

The answer to this first question is, then: The English system we now have is simple, is well adapted to textile requirements, and is in general use throughout the world. It is a good one.

We now come to the second question: What is the system we are asked to accept? The fatal defect in the metric system for textile work is the lack of any standard approximating the English inch. It is an undisputed fact that such a length is best suited for gauging the set or density of most fabrics. On this point I will quote from Donat, professor in the Royal Weaving School at Reichenberg, Austria:

The threads in warp and filling are gauged by the number per decimeter. The use of the centimeter is unsafe (unsicher), because from one-half to one thread (even more in silk goods) may easily be overlooked.

The decimeter, 4 inches, is impossible as a practical working standard for this purpose. Its use would make it necessary for the weaver when making a fabric like this to count frequently from 300 to 400 picks or shots of the shuttle at the rate of 90 per minute. The inch is still used in France and throughout the Continent generally for gauging the number of picks or filling threads.

It would be necessary for a weaver, in making such a fabric as in this gentleman's coat, with the decimeter, to count frequently from 300 to 400 picks or shots of the shuttle at the rate of 90 per ninute. This counting is necessary to keep the cloth uniform.

Mr. SHAFROTH. How would he have to count on the inch basis?

Mr. DALE. About one-quarter the number. He has to do this frequently in a noisy weave room. No reliance could be placed on a count of 300 or 400.

Mr. SHAFROTH. How many does he have to count with the inch?

Mr. DALE. It depends on the fabric. He would have to count about 60 or 70 for such goods as that gentleman is wearing.

Mr. SHAFROTH. If the centimeter were adopted, he would have to count about 30, would he not?

Mr. DALE. As I quoted from an Austrian metric authority, the centimeter is unsafe. It is not long enough. I does not give a fair average.

For expressing the width of narrow fabrics, such as ribbon and tape, we again find the metric system lacking. The following quotation on this point is from Frowein:

> The different widths of ribbon and tape often vary by one-fourth (French) line, the millimeter being too long for this measurement. It is greatly to be regretted that we find here an obstacle to its use for expressing widths, and thus bringing it into use in commerce.

The centimeter is too long for expressing the woven width of wide goods, and the millimeter is too long for expressing the woven widths of ribbon and tape. When indicating the weight of cloth, the ounce with its decimal divisions answers the purpose perfectly, while the metric system offers no unit approximating it. The decagram is too large, the gram is too small, and for this reason continental manufacturers are compelled to use such cumbersome expressions as 450 grams per meter, instead of the more concise and convenient 15 ounces per yard. The decimal divisions are decidedly inferior for measuring cloth, the method of successive halving as now used in this country being more natural and convenient. A customer wants one half and not five-tenths of a yard.

The names of the metric units are objectionable. Instead of short, distinctive expressions like yard, inch, ounce, pound, dram, and grain, we have the following names for the eight metric units to be used in the textile industry: Meter, millimeter, decimeter, centimeter, gram, kilogram, centigram, decigram.

The CHAIRMAN. Those are always contracted, are they not?

Mr. DALE. They can not be contracted in the mill, because the operatives are constantly using these words in conversation relating to their work, and such contractions as "mil" and "kil" would certainly lead to confusion.

Mr. SHAFROTH. If they contracted them, they would have to do it in self-defense?

Mr. DALE. Yes. If they are talking about them in conversation, they would have to say "dec," "mil," etc.

These foreign names are too long and too much alike for mill use.

The principal claim made for the metric system, however, is its superiority in making calculations. Before examining its advantages in this respect let us consider for a moment how far they are from realization. The metric system of numbering yarn is not the standard for any textile fiber in any country or manufacturing district on earth. No country, not even France, uses it for cotton, silk, or linen. It is used to a slight extent in the woolen mills of France and Germany, and I will show you presently what a chaos of yarn counts exists in French woolen mills.

Of course, the advantages of this or any other system can be reached only after it comes into general use. To bring that about the standards of every cotton, linen, and silk mill and of nearly every woolen mill on earth must be radically changed. The textile standards of every country, France not excepted, must be upset. Machinery, mill records, technical literature, and the ideas of every textile worker must be changed. The impossibility of such a revolution is so apparent that I might well stop here and say that, no matter what the advantages of the metric system of yarn numbering may be, they can never be attained. Let us, however, suppose that the impossible is accomplished and the metric system of yarn numbering adopted, what would be the advantage in calculations? By far the greater number of textile calculations are based on percentage and proportion and are as easily made by the English as by the metric system. In a single instance—namely, where one of the three factors, weight, length, or count, is to be calculated from the other two—the metric system offers an advantage; but this advantage is greatly reduced by the fact that our silk and woolen systems are decimal, and that our cotton and worsted standards are so easily commensurable with our decimal "run" standard that they can be reduced to a decimal equivalent by a mental calculation.

There is another class of metric problems whose solution by the metric system is made more difficult on account of the unsuitable size of the metric units. I will illustrate this by calculations for cloth analysis, and have analyzed for this purpose a sample of cotton and worsted vesting. Here are the calculations:

English.	Metric.	English.	Metric.
4.2)62.0(15 42 200 210	124 5 25)620(25. 50 120 125 5)124.0 24.8	1.8)31.0(17. 18 130 126	62 5 11)310(28. 22 90 88 5)62.0 12.4
(15)		(15)	(23)
FIG. 6.	FIG. 7.	FIG. 8.	FIG. 9.

WORSTED WARP.

English.	Metric.
7.0)130.0(19. 70 600 630	255 5 41)1275(31. 123 45 41 5)255 51.
(16)	(25)
FIG. 10.	FIG. 11.

COTTON WARP.

English.	Metric.
13 55 65 65 525)715.00(13.6 525 1900 1575 3250 3150	77 4 308 140 12320 308 431.20
(38)	(22)
FIG. 12.	FIG. 13.

COTTON FILLING. WEIGHT.

The sizes and sets of the yarn and the weight of the goods are then calculated, as shown at figs. 6 to 13 with the following result:

Worsted warp:
English, fig. 6, 15 figures.
Metric, fig. 7, 27 figures.
Cotton warp:
English, fig. 8, 15 figures.
Metric, fig. 9, 23 figures.
Cotton filling:
English, fig. 10, 16 figures.
Metric, fig. 11, 25 figures.
Weight of cloth:
English, fig. 12, 38 figures.
Metric, fig. 13, 22 figures.

A summary shows that 84 figures have been used in the English and 97 in the metric calculations.

The English system as it is used is here compared with the pure metric system which, up to the present time, no country has been able to make its textile standard. The English system is superior here because the size of the English standards gives an area that permits of direct calculations and affords the necessary accuracy and convenience in operation, while the metric system does not. Remember that the continental chaos of calculations is not illustrated here.

You will observe that 11 operations and 97 figures are necessary with the metric system, as compared with 5 operations and 84 figures with the English system. The reason for this is that one metric unit of area, the square centimeter, is too small for accuracy, being about half the size of a 2-cent postage stamp. A very slight error in weighing the threads of such a small piece of cloth would make a very serious error in the cloth itself and might make it unmerchantable. The other unit, the square decimeter, is too large for convenience, being about the size of an ordinary business envelope.

This is where the difficulty comes in with metric units of area. There is no unit between the centimeter and an area 100 times that amount.

The CHAIRMAN. You mean 10 times, do you not?

Mr. DALE. No, sir; I do not.

Mr. SHAFROTH. Ten centimeters make 1 decimeter.

Mr. DALE. Not square centimeters. One hundred square centimeters make 1 square decimeter.

Mr. SHAFROTH. You are right.

Mr. DALE. That is the trouble with cloth analysis. The successive units of area vary one hundredfold in size.

An intermediate size, which must be used, complicates the calculations because of the multiple of units.

The English units may be said to have resulted from chance. No one went to work and measured the distance between two points that could not be reached to determine the size of the inch. Nevertheless, that blind chance has resulted in giving us a system admirably suited for textile work.

With the English system we find that the area that affords accuracy and convenience is also suited for direct calculations. Where a difference in calculation exists between the two systems, the metric system is a positive handicap or its advantage is a mere bagatelle. This confirms in a striking manner the conclusion of John Quincy Adams that—

> The principle of decimal divisions can be applied only with many qualifications to any general system of metrology; that its natural application is only to numbers, and that time, space, gravity, and extension inflexibly reject its sway.

The metric system has been called international so often by its friends as to give currency to the idea that it has some peculiarity that fits it for being the world's textile standard. This is not true. The English units are better than the metric for textile work. Any one of the English ratios is as well suited for numbering spun yarn as is the metric. The English system has the additional advantage of already being in world-wide use. Unification of the world's textile standards by the English system is in sight, almost within reach. By the metric system it is an impossibility.

The answer to the second question is, therefore, that the metric system is not well suited to textile work and has the great disadvantage of being in very limited use.

We now come to the third and last question: Can we change from one system to another without difficulty?

The answer to this question may be based on personal observation of conditions in this country or on the experience of other countries where the change has been attempted. The extent of the territory affected, the influence of trade customs outside the mills, the technical literature and manufacturing records based on old standards, the vast amount of textile machinery built for production by the old standards, the natural difficulty of changing even one person's ideas of weight and length, the large number of people whose ideas would have to be radically and simultaneously changed, convince me that the project is impossible.

Take, for illustration, the task of changing counts or ratios between weight and length. The yarn count is used to indicate the quality of the wool. If wool is of such a length and fineness that it can be spun into worsted yarn measuring 30 hanks per pound the wool is called 30s; if into yarn measuring 80 hanks per pound it is called 80s. As the process of manufacture advances the operative's ideas as expressed by the yarn count are gradually modified. To the carder the yarn count has

a close connection between the quality of the material and the adjustment and preparation of his machine. The spinner finds it a definite measure for his work, and knows it indicates the length to which he must spin each pound of yarn. He can not measure the size of the thread with a gauge, as wire is measured, but must depend on the yarn count for that purpose. This is illustrated by these two samples of yarn, one of which is twice the size of the other. To the weaver it indicates the volume of the thread, the thickness of the cloth, and other innumerable ideas regarding textile structures.

Here are two samples of combed wool. You can see at a glance how much coarser one is than the other. To the wool sorter the difference in quality indicates the size to which he can spin the yarn. This one is marked 80s, which indicates that it can be spun to about 26 miles per pound.

Mr. GAINES. Where was that wool raised?

Mr. DALE. The finest, they told me, was raised in Tasmania. The other may be western wool. It is 30s. Thus, while that yarn count indicates the ratio between weight and length it also expresses the blood, fineness, and length of the wool to a large number of textile operatives. I mention this to show you how intricately the yarn count is connected with the ideas of textile operatives concerning manufacturing operations. It means one thing to one man and another thing to another, and yet all these different ideas are in harmony and contribute to the production of the perfect piece of cloth.

Even if you accomplish the practically impossible by driving out our basic units, the English yard, inch, ounce, pound, dram, and grain, there will still remain the English yarn counts, the expressions of intangible proportions between weight and length. The bases of our yarn counts may be reduced to a metric equivalent or to any other desired, but the yarn count itself remains as the standard for the work of the mill; the decimalizing of textile standards is then farther away than ever, and textile calculations are paralyzed by such bases as 768.08 meters per 453.58 drams, or 1,693.63 meters per kilogram, in both of which cases the yarn counts remain unchanged.

Those are the figures used in Germany to-day. When you see 768 meters in any of these books it means 840 yards. When you see 453 drams it means the English pound. I think no one will claim there is any advantage in changing from the English pound to an expression as awkward as 453 drams.

You can imagine how convenient that number (1,693) will be when calculating for the innumerable fabrics made for men, women, and children.

Mr. GAINES. Do you mean to say that in making a calculation there the calculation would be based on the long term you have just read?

Mr. DALE. Yes, sir. The yarn counts are so embedded in textile-mill practice that even if you drive out all other basis units, the yard and pound, inch, dram, and grain, you can not get rid of those yarn counts.

Mr. SHAFROTH. Your theory, then, is that it is impossible to adapt the metric system to the textile industry?

Mr. DALE. Yes, sir.

Mr. SHAFROTH. And if any other bill was passed the textile industry would continue right along in the same way?

Mr. DALE. Yes, sir.

Mr. SHAFROTH. Then the adoption of a bill would not injure your industry, would it?

Mr. DALE. Yes; in this way. You could crowd your meter and your kilogram into commercial measurement, and then the textile manufacturer would be confronted with the problem of manufacturing goods by the yard and pound to be sold by your metric units, which are incommensurable with the English units. You may get the kilogram and the meter into commercial measurements and transactions, buying and selling, but the manufacturer will continue to use the yard and the pound.

Mr. GAINES. It would not interfere with the textile industry if goods were sold by the meter instead of by the yard, would it?

Mr. DALE. The manufacturer would have to figure the cost of his goods. This is very important. Cost calculations should be simple. An error in figuring the cost of a fabric may mean a serious loss to the mill. The calculations would be greatly complicated. I will come to that later.

Mr. SHAFROTH. Do you not think it is as simple to measure cloth by the meter as by the yard?

Mr. DALE. Just as simple.

Mr. HALSEY. It is not a question so much of measuring it as it is of making it.

Mr. DALE. It is as simple to measure by the yard as by the meter.

A MEMBER. And a good deal easier by that principle.

Mr. DALE. The retention of the yarn counts is what has occurred on the Continent and explains the chaos of 33 spun yarn ratios shown on this card [showing card].

Here are the Anglo-American standards which I have just been mentioning. These diagrams are drawn to a scale. Each of the English standards, which is confined to a single material, is based on the yard-pound. Now turn to the Continental systems. They have reduced a number of them to the metric system and many they have not. They use the Paris pound, the Vienna pound, the Leipzig ell, the Vienna ell, etc.; these are the basic standards. The upright line represents the length of the skein. This proves that you can not get rid of the yarn counts. Reduction to the metric or any other system merely changes the method of expressing the bases.

The old expressions of length have been partially changed, but the old ratios remain the same. Look at the metric equivalents in the last column. The adoption of the metric system has given the miserable textile workers of continental Europe such bases as 1.77, 2.96, 0.71, 3.05, 2.99, etc. I can cite no parallel to the difficulty of changing yarn counts. It involves greater difficulties than does the alteration of screw threads and land measurements, for with yarn counts we must reckon not only with the weight and length of tangible material, but also with the intangible ratios between weight and length.

This is why I say you can not change our textile standards. There are men, however, whose opportunities for observation are equal if not superior to mine who assert that these standards can be changed without difficulty, and the opinion was expressed before this committee two years ago that such a change can be made in two years.

Fortunately you need not rely on anyone's opinion. For one hundred and ten years France has been trying to change her weights and measures under conditions and with results that can be readily learned.

The conditions in France were so favorable that speedy success there would not warrant the conclusion that a change is possible under the adverse conditions here. Failure in France, however, is absolute proof that a more complete failure is certain here.

Proof of the failure in France is overwhelming. It is found in every recent French textile journal and handbook, and is admitted by Frenchmen themselves. I will read a few extracts from French sources. Paul Lamoitier, a French textile manufacturer, wrote to L'Industrie Textile, Paris, in October, 1902:

Ah! These Americans are not considerate of our feelings, and they are right. We are as much in the anarchy of weights and measures for the textile industry as at the time of the Revolution, for we have the denier of Montpellier and of Milan for silk, with the aune as a unit of length. We still have the diverse standards of Roubaix, Fourmies, and Reims for worsted, the moque of Sedan, the livre, the quart, and the sous of Elbeuf, the yard for linen, etc.

Additional testimony from the same source will be found on this card:

A French description of French textile weights and measures in October, 1902. Paul Lamoitier, St. Michel, France.—The argument of the Americans is this: "What! We are nearly 41,000,000 of English and 76,000,000 of Americans, who have the same system of weights and measures and constant relations with each other, and shall we change our system?"

O! the noble, the good, the egotistical, and above all the naive reason! For in reality they mean to say: We are dependent on England in our commercial exchanges, and shall we change our system of weights and measures while the English are so friendly to us?

Mon dieu! That you should remain stubborn and not adopt it, is for the above-named nations and for France but a secondary consideration. The metric system wins its own way because it is the most simple, the most logical, practical, uniform, and universal.

This article, however, is not written for Americans. Nevertheless, they are perfectly right in speaking of our "European chaos" of yarn numbering, and I will attach their argument to my remarks, not for the purpose of going backward like them, who would return to the ancient aune and the greater chaos of ancient and absurd measures.

It is absolutely unworthy of us French, who were the first to find and apply the metric system, to retain the aune and the denier for measuring silk. Ah! these Americans are not considerate of our feelings, and they are right. We are as much in the anarchy of weights and measures for the textile industry as at the time of the Revolution, for we have the denier of Montpellier and of Milan for silk, with the aune as a unit of length. We still have the diverse standards of Roubaix, Fourmies, and Reims for worsted, the moque of Sedan, the livre, the quart, and the sous of Elboeuf, the yard for linen, etc. Ah! the famous aune—do you know its equivalent? Exactly 3 feet 7 inches 10 lines and 10 points; or, in other words, 1.188447 meters; the foot being equal to 0.324839 meter, and divided into 12 inches, the inch into 12 lines, and the line into 12 points.

You would not imagine this, as you are in the habit of calling it 1.19 meters.

You laugh!

It is, however, no laughing matter, unless you consider it, as I do, profoundly ridiculous.

And what do we find here? The yarn count in the north of France is a length and in the center a weight. I will take my oath that the manufacturer of Rouen, if he has not studied each section separately, has no idea what is the standard of Reims or the denier of Lyons or Milan. And, on the other hand, the manufacturers of Reims and Lyons are likewise puzzled in making comparisons of the diverse numberings of the diverse materials.

And this is the reason why they are right in mocking us when they say we do not use the metric system for numbering yarn and for weaving calculations. Nothing is more arbitrary than to reckon the yarn by the thousand meters and the width of the cloth and the picks of the filling by the inch. It is nonsense and a derision. Note also that while I speak here only of France I could say as much of all Europe. For example, do you know that the Russian reckons the width of his cloth in verschki, the picks by the quarter inch, and the yarn by either the French or the English systems? One verschok equals one-sixteenth of an archin.

This is what I should like to see established. It is a duty and would be a glory to our Government to decree the unification of yarn numbering, the unit of length being the kilogrammeter (1,000 grams and 1,000 meters). Oh, no need of a long statute. Two articles:

"Article 1. Textile materials shall be numbered by the number of thousand meters in a kilogram.

"Article 2. All other systems of yarn numbering are forbidden on French territory."

The advantages? It would put a stop to the chaos which the Americans ridicule. It would give us a uniform and known system easily comprehended, simple and universal as the metric system itself, allowing quick comparisons, simplifying and facilitating calculations and general transactions, preventing fraud and dishonest accounts, and enabling the governments to establish uniform standards for all textile materials.

In short (this for the Chauvinists, and, consequently, for all of us), they would not ridicule us any more. It is not pleasant to be thus continually ridiculed by foreigners, especially when they have reason for doing so.

After having established the metric system, is it not truly ridiculous that more than one hundred and ten years later we should be still using the English yard, the old or French pound, the denier of Montpellier or of Milan, the ancient aune, the many different skeins, etc.?

In the future, more or less remote, we shall accomplish the unification of yarn numbering. The reform advances of its own accord.

In the face of foreign sarcasm, it should be established at the earliest possible moment.

As for the recalcitrants (English, Americans, and others), a very simple procedure will be to oblige them, in all countries where the metric system is legal, to mark their yarns by the metric system.

Let us say to them: "Do you want to trade with us? Then confine yourselves to that which is the most simple and the most practical."

A large saving will be made in this way in the cost of collecting custom duties in the metric countries. There is no better way than this to make them repentant.

The CHAIRMAN. Mr. Paul Lamoitier is a strong advocate of the metric system?

Mr. DALE. Yes, sir; a very strong advocate of it.

The CHAIRMAN. And his contention is that the metric system would be a great convenience and improvement in the textile industry?

Mr. DALE. It depends on whom he is talking to as to what his contentions are. At the end of the first chapter of The Metric Failure in the Textile Industry you will find his statements in parallel. I invite your careful attention to them. On one side appears what he said to Americans.

Between June and September, 1902, I quoted freely from his book to show the chaos of textile standards in France. In October, 1902, he published in L'Industrie Textile, Paris, a two-page article addressed to Frenchmen, in which he covered them with reproaches for their neglect of the metric system and clamored for just one more law, just a little one—to make them use the metric system.

The CHAIRMAN. I see you are the author of this book. How did you come to study so much into this metric system?

Mr. DALE. I had been a textile worker, and I found the subject to be deeply interesting. That accounts for my work in this line.

The CHAIRMAN. You did not expect a rainy day was going to come when you would have to pull that book out in self-defense and read it in defense of your textile business, did you? In other words, you printed the book because you had studied the subject and not for the purpose of making an argument?

Mr. DALE. That is it. This book has been in preparation a long time.

Mr. HALSEY. And you might say that when you began that inquiry you were in favor of the metric system and that you changed?

Mr. DALE. I can not call my belief when I started the inquiry anything that amounted to very much. I had studied the metric system in schools, and the idea had been instilled into me that it was the scientific thing. It had also been instilled into me that it was spreading irresistibly all over the world. My ideas were very vague. It was a prepossession in favor of the metric system.

The CHAIRMAN. Did you ever use the metric system in your work?

Mr. DALE. In common with the rest of humanity, I have not. As I have already stated, the metric system is not the standard for any textile material in any manufacturing district on earth, judging by the evidence from German, French, and other foreign sources. I have not used it, and neither has anyone else, so far as I can learn.

The CHAIRMAN. What is the comparative number of spindles which are operated in this country and in the old country in the cotton industry?

Mr. DALE. It is estimated that there are 105,000,000 cotton spindles in the world, and 68,000,000 are in England and this country. We have 23,000,000 and England 45,000,000. The remaining 37,000,000 are in Japan, India, continental Europe, and other countries.

The CHAIRMAN. Do you not think that the predominating amount of business done in this country and in England, where the English system is used, may have the effect of rather smothering out any other system?

Mr. DALE. It certainly does.

The CHAIRMAN. Supposing the comme cial system and the system among the people—the system generally understood—should be the metric system, what effect would that have on it?

Mr. DALE. We are so far away from such a condition that it is not worth while to consider the merits of the pure metric system. The answer to your question is included in my answer to your second question.

The CHAIRMAN. During the hearings had before this committee two years ago I remember we had several textile men here.

Mr. DALE. Two.

The CHAIRMAN. And they complained of confusion existing in the textile industry in regard to weights and measures.

Mr. DALE. I have never found it. There are only two measures of length, the yard and inch, and there are only four of weight, the pound, ounce, dram, and grain. In basic units we could not get along with one less, and we do not want one more. We have those five systems of numbering yarn, each one of which is confined to a particular kind of yarn.

The CHAIRMAN. Do you think the men engaged in the textile industry are less intelligent, less capable of taking on a new system, than other people?

Mr. DALE. That is a rather broad question. I would not want to say. I am not so well acquainted with other industries, but I have worked with textile workers for years. I have worked with them and over them as overseer and superintendent. I have been responsible for their work, and I found it difficult enough to keep them in the right line with one set of standards. They work long hours. In many sections of the country the percentage of illiteracy is high. They are flocking from the mountains to the mills, and they are thinking in these English units. My opinion is that you can not change their ideas. I

do not want you to accept my statement, and I have been, therefore, citing evidence from foreign metric sources.

Mr. GAINES. Are the textile manufacturers opposed to this measure, or rather not to this measure, but to the metric system?

Mr. DALE. There has been no vote and they are not holding any meetings or passing resolutions declaring that they are satisfied with the length of the inch and the weight of a pound.

Mr. GAINES. Are you satisfied with the present weights and measures?

Mr. DALE. I am; yes, sir. And I would consider it a national calamity if you should succeed in injecting any other standards—no matter whether they are metric, Rhenish, or what not—into our industry with our present units. It is not alone the metric system that I am opposed to; it is any two ways of thinking about length or weight. You can not make the change complete.

Mr. GAINES. Do we export textile goods?

Mr. DALE. We export cotton goods, mostly to China.

Mr. GAINES. Is there any trouble because of our weights and measures?

Mr. DALE. I believe not. The textile tariff of China is based on the English units of weight and length and yarn counts. I recently came across a Government publication referring to the Philippine Islands which gave the practice of testing yarn counts. Spain used the metric system in Government work. It was compulsory, but in testing cotton yarn they use the number 59 for testing yarn counts, and if you look on this table of equivalents you will find 59 as being the ratio between the English yarn count and the metric system. That is just as near as they get to decimalizing standards by adopting the metric system for Government work.

A MEMBER. And the present system is more practical and more easily managed? You work under it more easily than you could under the metric system?

Mr. DALE. I would not want to say yes or no to that. Much could be said on that question.

The CHAIRMAN. You mean a yarn count is so many threads to an inch, do you not?

Mr. DALE. Oh, no.

The CHAIRMAN. What do you mean by a yarn count?

Mr. DALE. Here is a sample of worsted yarn spun by the Saxony worsted mills. It is marked 32s. That means that a pound of it measures 32 lengths of 560 yards each, or about 10 miles. The 32 indicates the number of lengths or hanks per pound. That is what is meant by yarn counts.

Mr. SHAFROTH. Of 560 yards each?

Mr. DALE. Yes, sir; that is used for combed wool or worsted, and if you say 32s worsted in this country any textile workman knows what you mean at once. If you are talking of cotton yarn and say 32s it means that there are 32 hanks of 840 yards each in 1 pound. If you are talking of linen yarn the count indicates lengths of 300 yards each. We have, as I said, five systems, each confined to one kind of material.

The CHAIRMAN. My recollection is that that is just what some of them were complaining about.

Mr. DALE. The English system is the result of evolution. If we

could begin over again, there is no question but that it would be better to adopt one method of expressing these ratios for all textile materials except silk.

The CHAIRMAN. Is that what the textile men are clamoring for?

Mr. DALE. No, they are not clamoring for it.

The CHAIRMAN. According to the statements we get here, I know there is great dissatisfaction about weights and measures.

Mr. DALE. There is great dissatisfaction in Continental Europe. I have never found it in this country.

The CHAIRMAN. Why should the Lowell textile school, through its board of directors, pass a resolution looking to the adoption of the metric system if the system which they have is satisfactory and is almost universally used?

Mr. DALE. I would rather let the Lowell textile school and its directors answer that question. As for myself, I think it is absurd to teach the metric system in the school and then let the student go from the school to the mill and use the English system for earning his living.

The CHAIRMAN. It would seem so, if the weights and measures were satisfactory.

Mr. DALE. I do not hear of any dissatisfaction. It was stated at your last hearing here that the New England Cotton Manufacturers' Association had passed resolutions in favor of the metric system. I was at the meeting and heard the discussion on metric yarn numbering, and I did not hear of any resolution. I wrote to Mr. Woodbury and he replied that the Association had never committed itself to the metric system of numbering yarn.

Mr. SHAFROTH. Is not considerable complication caused by the fact that you take a hank of 560 yards in one instance and 840 yards in another instance? Why would it not be better to establish a system based, say, on a mile length per pound, gram, ounce, or whatever standard you would take? Why would it not be easier to do it that way?

Mr. DALE. There is no question but it would be easier, and if we had to begin over again and establish a system, one ratio would be better for all kinds of yarn except silk.

Mr. SHAFROTH. Why do you make an exception of silk?

Mr. DALE. Because in the case of silk the worm spins the yarn; in the case of cotton the man spins it. The worm spins the silk filament sometimes as fine as 1,100 miles per pound. It requires the most delicate touch to get the different strands together and make a thread strong enough to weave. The process for cotton is to draw a coarse strand gradually finer. In worsted, linen, and cotton the threads are drawn finer to get the thread. In silk additional strands are added to make the yarn heavier until a thread that will weave is obtained. That is a rather technical point, but it explains in a general way why the silk manufacturer uses a fixed length system for numbering yarn. The ratio is expressed by the weight.

Mr. SHAFROTH. Of a given length?

Mr. DALE. Of a given length.

Mr. SHAFROTH. They keep that length uniform, do they?

Mr. DALE. They keep it uniform because it can not be drawn any finer. They keep adding to it, whereas with wool the strand is drawn

finer. The yarn count gets higher as the process advances in either case.

Mr. SHAFROTH. Then the silk system, in your judgment, is more perfect than the wool system or the cotton system?

Mr. DALE. I do not know that I could say that. The difference between them is due to the inherent difference in the process of manufacture.

Mr. GAINES. What would have to be done to make a mill conform to the metric system? What changes, if any, would be necessary if we were to adopt it by January, 1906, and what would it cost?

Mr. DALE. I can not answer that question. The first thing to be done would be to instruct the help who do the measuring and weighing in the new system. You would have to make them think in the new system. That would be a thing which you could not do. Then the machinery would have to be changed. As Herr Münch-Ferber said in Germany, their machinery is based on the English system. He said it would throw the system into "ungodly disorder" to attempt to introduce the metric system into the textile industry.

Mr. GAINES. You would have to teach your employees this system and make your machinery over to conform to that system?

Mr. DALE. Yes, sir; and there is the technical literature, the books in the possession of the workmen.

Mr. GAINES. You would have to teach them to start thinking the new way.

Mr. DALE. Yes. You could not do it any more than you could teach them to talk French after a certain date.

Mr. SHAFROTH. That is on the theory that it is compulsory.

Mr. GAINES. What good is it, Mr. Shafroth, unless it is compulsory?

Mr. DALE. Additional testimony from M. Lamoitier will be found on this card.

The only metric ratio between weight and length is based on 1,000 meters per kilogram. This is not used for cotton, linen, or silk. It is used to a slight extent in France for woolen yarn, and I will let M. Desire Chedville, a French woolen manufacturer, say how much.

He said this at the Paris metric congress of 1900, when he probably did not expect to be quoted in this country; and remember this was one hundred and ten years after the adoption of the metric system in France:

> We hope no new burdens will be imposed on the (woolen) industry, but if we look the facts in the face we will find that notwithstanding the decree of 1810, and in spite of the serious efforts put forth by the industrial societies of many districts, we still have the ancient units of weight and measure, and we scarcely comprehend each other when we talk of spinning at Reims, Roubaix, Elbeuf, Sedan, or Vienne, where the skeins measure 1,420, 710, 3,600, or 1,500 meters.

That is not using the metric system, understand.

Mr. SHAFROTH. It is the arbitrary ratio they have adopted.

Mr. DALE. The equivalents of old ratios. For instance, take 710; it is equal to 600 Paris aunes. How much better off they would have been if Napoleon's advice had been adopted, and instead of using the metric system they had simply extended the Paris system through France. They would now have 600 instead of 710 for their calculations.

I am coming now to metric testimony. I do not ask you to accept my opinion, but we will have to accept the evidence from metric sources.

When the metric system was established in France the silk industry had already reached a high state of development, because the most difficult part of silk manufacturing is done by the worm, and was as well done in 1790 as in 1904. The difficulty of changing silk manufacturing standards was so plain that no attempt was made to force the metric system into the French silk industry until 1866. The decree of 1866, providing for a silk-yarn standard is still the law of France. At the Paris metric-yarn congress of 1900 M. Edouard Simon stated its effect in the following words:

> We deem it opportune to ask for a change in the law of 1866, which made the number of silk to indicate the weight in grams of 500 meters. This legal system has remained a dead letter.

The French denier-aune has become the world's standard for raw silk and, with the exception of Great Britain and the United States, for thrown silk as well. The silk workers of France are all in favor of the metric system, but they continue to use the denier and the aune because their wants, necessities, and habits, and the trade customs of the world are stronger than the will of the French people or the power of French law.

Besides this personal testimony I have here one of the latest French books on textile manufacture—Lamoitier, Traite de Tissage. All that part of the book relating to textile measurements is involved in a hopeless confusion of incommensurable standards. It is representative of French textile literature and proves beyond question the failure to make the textile standards of France metric.

A memorandum will be found on the fly leaf of each book calling attention to a few typical examples.

I have also some recent textile books showing the condition of affairs in Germany, Austria, Italy, and Spain. I want to call your attention not only to the confusion of old and metric standards, but also to the prominent place occupied by the English standards in French, German, Italian, and Spanish practice, as shown by these books.

Here is a Spanish handbook on cotton spinning, Guia Practic pera la Filatura del Coto; and an Italian treatise on textile manufacturing, Tessuti di Lana e di Cotone.

This one, Kalkulator fur Textilbranche, is a handbook for German textile operatives. The whole book is a mass of confusion.

Here is the most complete treatise on textile manufacturing that I have seen, Die Deutsche Webschule. It exhibits the same confusion of standards.

Here is the gem of the collection, received from Germany a few weeks ago. It is the Metric Lightning Calculator for the German textile industry (Das metrische Schnellrechnen für die Textil-Industrie.) This is no treatise on general principles. It is a collection of short cuts in textile calculations compiled for the German textile workers for 1904.

And what is this lightning metric method?

From beginning to end nothing but a labyrinth of tortuous processes, based on the use of constant numbers, called Schlüssel, the ratios

between the metric units, which the drastic German law says the people must use, and the old units which they do use.

Mr. SHAFROTH. Notwithstanding that, is it not a fact that the German and French goods are as fine as any manufactured anywhere?

Mr. DALE. Yes, sir.

Mr. SHAFROTH. And that they are imported into this country with as little difficulty as English goods?

Mr. DALE. The tariff is so high now that woolen goods can not be imported.

Mr. SHAFROTH. That would exclude the English goods too, would it not?

Mr. DALE. Yes, sir.

Returning to the German lightning calculator, this is the very best the Germans can do thirty-four years after the metric system was made compulsary. And yet men can be found who profess to believe that the metric system was adopted in Germany in 1871 without difficulty.

Testimony to that effect was given before your committee last session. One man said he was there and saw it done.

The energies of Continental textile manufacturers are exhausted in constant conversion from one incommensurable standard to another. Direct calculations are impossible and the useful relations between textile weights and measures are hidden from sight. In many respects they excel us in textile manufacturing, but are far behind us in textile calculations. One will search in vain through French and German textile literature for new and useful methods or concise and clear statements of direct textile calculations.

The European chaos of weights and measures is well illustrated by the estimate of cost of cotton tape found on page 92 of Frowein's Kalkulator.

In this estimate a separate column is inserted for prices per English pound, showing the prominent place occupied by this Anglo-American standard in the textile industry of Continental Europe. The reed is gauged by the number of dents per French line. The yarn counts in both warp and filling are English, based on the 840-yard standard. The picks of filling are given as so many per French inch. The weight of the warp yarn is calculated in metric grams from the English counts, and extended at a price in marks per English pound. The length of the filling yarn is calculated per 100 meters of cloth from the picks per French inch and the width in French lines. The weight of the filling in grams is then calculated from the English yarn count and the length in meters. This weight in grams is then extended at a price in marks per English pounds.

All of this blind staggering among a lot of incommensurable units, consisting of the French inch, English yard, metric meter, French line, English pound, and metric gram, is necessary to arrive at the cost of cotton tape measured lengthways in meters and widthways in French lines. This is a simplified method of "using the metric system in Germany." It shows what the United States must come to if the system is ever introduced here.

These are the operations:

The reed is gauged by the number of dents per French line. The yarn counts in both warp and filling are English, based on the 840-yard standard. The picks of filling are given as so many per French line. The weight of the warp yarn is calculated in metric grams from the English counts, and extended at a price in marks per English pound. The length of the filling yarn is calculated per 100 meters of cloth from the picks per French inch and the width in French lines. The

weight of the filling in grams is then calculated from the English yarn count and the length in meters. This weight in grams is then extended at a price in marks per English pound.

There is the reproduction of an estimated cost. Books like this are mostly handbooks that the workmen carry in their pockets. They are not philosophical treatises. They are practical books which the people use in their daily work. Here is another example of how the Germans are "using" the metric system:

The table taken from the Leipziger Monatschrit of October 31, 1902, illustrates the confusion of German standards and how deeply the English yard pound is embedded in German textile literature and practice. It has been compiled for daily use by weavers in reckoning the amount of yard required for orders. It is called: Theoretical requirements of yarn for 100 meters of cotton cloth 100 centimeters wide, in English pounds. This is bad enough, but worse is to come. The yarn counts at the head of the columns are English based on 840 yards per pound. At the left the set is given in threads per Vienna inch. The Austrian weaver runs his eye down the columns headed "English yarn No." until he reaches the line at the left of which is the set in threads per Vienna inch, and there he finds the weight in English pounds of the yarn he needs for 100 meters of cloth 100 centimeters wide. And this is also called "using the metric system."

I can not exaggerate the continental confusion because words fail utterly to describe it. The more the situation is studied the worse it appears. There can be no question of the failure to change continental standards to the metric system, and it is certain if the French in one hundred and ten years and the Germans in thirty-four years have failed to drive out their old units—the aunes, ells, inches, pounds, deniers, and yarn counts—the English yard, inch, pound, ounce, dram, grain, and counts will successfully resist all efforts to drive them from America.

The attempt to change textile standards in France has continued for more than a century and to-day is an admitted failure. There the attempt was made under the most favorable conditions; here the conditions are all adverse to success. There the textile industry was carried on by hand and foot power; here textiles are manufactured almost wholly by power and hand machines have disappeared. Then textile weights and measures were comparatively unimportant; now there is not one of the many textile processes whose success does not depend upon their accurate adjustment. There a change was necessary because of the great diversity of standards; here a practical uniformity of weights and measures forbids a change.

There a change of old standards caught the popular imagination and became part of the national creed; here the people are satisfied with their standards and have a deep-rooted prejudice against the adoption of any foreign system. Then not a solitary power cotton spindle was in operation in France. Now we have 23,000,000 in this country. There 6,000,000 spindles have been installed in one hundred and fourteen years. Here more than 6,000,000 spindles have been started in the South alone in twenty-four years. Then France was but three-quarters the size of Texas; now we have an area nineteen times that of France. Then there was a population of 26,000,000 in France; now we have a population of 80,000,000. There the population has increased 12,000,000 in one hundred and ten years; here it has increased 12,000,000 in ten years. There the new system has been forced at the point of the bayonet on a people accustomed to obedience to arbitrary law; here the people firmly believe that they have a right to measure

and weigh things as they choose. There the attempt has failed with all the conditions favoring the change; here failure is certain, because every condition is adverse to the change.

FRENCH METRIC LAWS THAT HAVE FAILED.

Decree of August 1, 1793:

ARTICLE 1. The new system of weights and measures founded on the measurement of the earth's meridian and the decimal division will be used throughout the Republic.

On September 23, 1795, the following decree provided that the meter should take the place of the aune:

ARTICLE 1. On 1 nivose approaching the use of the meter is substituted for that of the aune in the commune of Paris, and ten days after that date in the department of the Seine.

ART. 2. In consequence all merchants, both retail and wholesale, stationary and traveling, who use the aune are ordered to procure meters.

ART. 11. The police will make in their respective arrondissements, and several times during the year, visits to the shops and stores, public places, fairs, and markets to test the weights and measures.

All violators of this ordinance will be punished by the confiscation of the illegal measures, and will be brought before the police tribunal where a fine will be imposed to suit the case.

Decree of 1810:

ARTICLE 1. On and after March 1, 1811, all proprietors of spinning mills shall make the hanks of cotton, linen, hemp, or wool, each 100 meters long, so that a skein shall measure 1,000 meters in length.

ART. 2. These yarns shall be ticketed with the number of such skeins in one kilogram.

ART. 3. Violations of the foregoing provisions shall be considered breaches of the police regulations and punished by a fine of not less than 5 nor more than 15 francs for the first offense; the fine may be increased for a repetition of the offense.

Decree of 1819:

ART. 2. On and after October 1, 1819, all cotton spinners of the kingdom shall reel their cotton yarn in 100 meter hanks, of which 10 shall make 1 skein of 1,000 meters.

ART. 3. To accomplish this object all the said spinners shall adopt new reels or alter those they now use so that in future all mills shall be equipped with hexagonal reels of 1,428¼ meters, provided with a wheel or counter of 70 teeth.

ART. 4. On and after the same date all cotton from French mills shall be ticketed with a number indicating the number of hanks forming a pound or demi-decigram.

ART. 8. Cotton yarn which may be found after October 1, 1819, without the mark indicating the factory or country of origin will be seized. If after a trial by jury the yarn shall be found to be of French origin, the owner or person in whose possession it was found will be fined 6 per cent of the value of the yarn.

NAPOLEON AND JOHN QUINCY ADAMS ON METRIC FORCE BILLS.

NAPOLEON.

The geometers, the algebraists, were consulted in a question which was, in fact, purely one of an administrative character. They thought that the unity of weights and measures should be deduced from some natural order, so that it might be adopted by all the nations.

The law needed for this matter was so simple that it could have been written out in twenty-four hours and could have been adopted and put into practice throughout the whole of France in less than a year. All that was required was to make the units of weights and measures of Paris the only legal units throughout France.

The Government and the artisans had for generations past used these weights and measures.

By sending standards to every commune and by ordering the administration and the tribunals not to recognize any others this reform would have been carried out without trouble, inconvenience, or coercive measures.

JOHN QUINCY ADAMS.

These purposes, regulation of weights and measures, however, require powers which no legislator has hitherto been found to possess. The power of the legislator is limited by the extent of his territories and the numbers of his people. The principle of universality, therefore, can not be made by the mere agency of his power to extend beyond the inhabitants of his own possessions. The power of the legislator is limited over time. He is liable to change his own purposes. He is not infallible; he is liable to mistake the means of effecting his own objects. He is not immortal; his successor succeeds to his power with different views, different opinions, and perhaps different principles. The legislator has no power over the properties of matter. He can not give a new constitution to nature. He can not repeal her law of universal mutability. He can not square the circle. He can not reduce extension and gravity to one common measure. He can not divide or multiply the parts of the surface, the cube, or the sphere by the uniform and exclusive number ten. The power of the legislator is limited over the will and actions of his subjects. His conflict with them is desperate when he counteracts their settled habits, their established usages, their domestic and individual economy, their ignorance, their prejudices, and their wants; all which is unavoidable in the attempt radically to change or to originate a totally new system of weights and measures.

I ask you to profit by the experience of France and abandon this metric bill. It can result in nothing but confusion for succeeding generations.

I find some comfort in the thought that even if the bill passes its absurdity will cause its speedy repeal and thus prevent the disorder from spreading beyond a few helpless government employees who must use the official system or lose their official heads. If that hope is a mistaken one, the American textile workers of the thirtieth century will look back with regret at the lost uniformity of 1904 and curse the folly of the twentieth century that threw the thirtieth into a hopeless confusion of incommensurable weights and measures.

The CHAIRMAN. Do you know of any country where the metric system was adopted where there is even an effort to repeal it, outside of Turkey, which was referred to?

Mr. DALE. You mean on the general proposition?

The CHAIRMAN. Yes; not relating to textiles.

Mr. DALE. I do not; but as I say, my investigations——

The CHAIRMAN. In relation to Turkey, is it not a fact that Turkey was endeavoring to inaugurate the system, but before it had time to go into effect they repealed the law?

Mr. DALE. I am not familiar enough with the facts to answer that question.

The CHAIRMAN. Did they ever actually put in force for any length of time even the meter there? How about that, Mr. Halsey?

Mr. HALSEY. They went far enough to destroy all those in Constantinople.

Mr. BROWN. In your researches into this question do you know of any country that has abolished a uniform system to adopt the metric system?

Mr. DALE. I do not. In the textile industry the attempt to adopt it is confied to metric countries, and you may count them on the fingers of your hand. In Continental Europe there was a chaos of old standards. English supremacy in the textile trade has been too strong and to-day, in the linen industry, for example, the English standard is universal.

They can not get away from it. Here is an extract from a metric source:

[M. Louis Guerin, Paris Metric Yarn Congress, 1900.]

It is practically impossible for us (the French) to sell linen by any other than the English standard. * * * If the law of 1810, providing for the metric standard, is in force, we shall be the first to complain of that which we have asked for.

Mr. BOWERSOCK. Has there ever been any movement in France to do away with this action taken in adopting the metric system?

Mr. DALE. I do not think there has. It is a national idol there. They are unanimously in favor of it, but they can not use it.

Mr. SHAFROTH. That is, in textiles?

Mr. DALE. Yes. They can not get where they can use it. Their effort is futile. It is pathetic.

Mr. SHAFROTH. Let me ask you this question: You say the inch is about the proper length of the standard in yarn measurements?

Mr. DALE. Yes, sir.

Mr. SHAFROTH. You say that the centimeter is too small and the decimeter is too large, and that the inch, which has been adopted, is about the right size?

Mr. DALE. Yes, sir. In making cloth the yarn is spun as you see it on this bobbin. Then the threads are placed side by side for warp and other threads are passed back and forth with a shuttle for filling. That makes the cloth. The number of threads per inch in the cloth is what we call the set.

Mr. SHAFROTH. You say the inch is about the proper length?

Mr. DALE. The inch is the proper length.

Mr. SHAFROTH. Now, in the conversion to the metric system, where would the inconvenience be to adopt, say, three centimeters, which is about the length of an inch, and call it an inch, or call it anything else?

Mr. DALE. The natural tendency of the human mind is to select the line of least resistance and use integral numbers, say so many threads per unit. Three is more awkward.

Mr. SHAFROTH. Yes; I know.

Mr. HALSEY. And do you not see it destroys your beautiful decimal ratio?

Mr. SHAFROTH. It does to some extent; but still it would have a relation to the meter and have a relation to these others which the inch does not bear.

Mr. DALE. The practice for counting picks per inch in cloth in France to-day is by the French inch. They do not use the metric system.

Mr. SHAFROTH. Is that the same as the English inch?

Mr. HALSEY. No; it is on that scale I gave you there.

The committee thereupon adjourned until Monday, January 25, 1904, at 10.30 o'clock a. m.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., January 28, 1904.

The committee met at 10.50 a. m., Hon. James H. Southard in the chair.

Statements were made to the committee concerning the metric system by Mr. Henry Harrison Suplee, of New York, editor of the Engineering Magazine, and Mr. Ernest F. Du Brul, of Cincinnati, Ohio, commissioner of the National Metal Trades Association.

The CHAIRMAN. The committee will be in order. We have two gentlemen here this morning who will speak—Mr. Suplee and Mr. Du Brul; and we have understood that Mr. William Sellers would be here this morning also. He wrote us to that effect. If he comes, of course we will have only less than an hour for the three; so I shall have to ask you gentlemen to be as brief as possible, although I do not want to limit you, but merely ask that you will be kind enough to say what you desire to say in the briefest compass.

STATEMENT OF MR. HENRY HARRISON SUPLEE, OF NEW YORK.

Mr. SUPLEE. Mr. Chairman and gentlemen, before I proceed, there is one point I should like to make, and that is for a good many years past I have been acquainted with both systems—the metric system and the system of weights and measures at present in use in this country. I have had occasion to use the metric system so as to become familiar with it on its own basis. A kilogram means a kilogram, not so many pounds, and the measure of length is the same way; and what I shall have to say is based on my own personal experience.

Mr. GAINES. What is your business or profession?

Mr. SUPLEE. I am a mechanical engineer. I am now an editor of an engineering magazine. One portion of my duty in that capacity is to read and abstract foreign periodicals. Every month there appear before me about 150 papers in foreign languages—French, German, Italian, etc.—and I abstract them and render them into English.

Mr. GAINES. You have worked in both systems?

Mr. SUPLEE. Oh, yes; in my apprenticeship, especially, I worked as a draftsman, and since then also.

Now, in the first place, I think there is a misapprehension about the advantages of the metric system, and about the advantages of any system, in fact. Uniformity is very much more important than is the practice of any one system; and the advantages of one system over another are of very much less importance, to my mind, than the advocates of either of the two systems would desire to have it appear. The advantages of either system are those which have accrued to it by usage rather than by any inherent advantages. It is very largely a matter of facilitating individuals, rather than the inherent qualities of the system.

Another point is, that I think the metric system is misrepresented in some respects as to the extent to which it is getting into use. It is not unusual for some people to estimate the progress of the metric system by citing the populations of the countries which are supposed to use it, or the countries which have legally adopted it. The fact is that very many of those countries are composed of people who do not manufac-

ture very much, and do not use measurements precisely. Speaking from a mathematical point of view, population is not a criterion or standard of the use of a system by any given number of people. It might be said, for example, that the use of the British system in British India would be a use by so many millions of people. But that is not a legitimate argument. The extent to which a system is used should be measured by the industrial development of the people who use it rather than by the number of people nominally using it.

The third point to which I wish to ask your attention is, that it would be a mistake to introduce, either into all our Government departments or into our country at large, a system which would be nominally a metric system, but which in fact would be merely a conversion system—that is, using English measurements expressed in the nearest metric equivalents. I think it would create confusion and harm to both systems. I fully believe that both systems can work side by side. One system may be in some cases preferable to the other. The usage should come by contact with the measurements themselves rather than from any attempt to use them by conversion. A converted system is not a legitimate or true or desirable system.

That is another point. In my use of it I practically think back and forth in the metric system in connection with our present system.

Mr. GAINES. What do you say is a converted system?

Mr. SUPLEE. A bolt that is, say, an inch long is about 25 millimeters long. Make a 25 or 20 millimeter bolt, if you will, but do not make it as a corresponding measure to the old system. I think that would make confusion.

I should like to make a few notes here in regard to what is done in France. I have here something written in the French language on the metric system of weights and measures. It is a work by G. Bigourdan, of the Paris Observatory, and is entitled "Le Système Métrique." It is a complete history of the metric system and the laws belonging to it, and the manner in which it grew in France, and the way in which it became adopted there. I have noted here briefly the three legal enactments in France which introduced the system. The first was in the eighth year of the Republic, the year 1799; and that announced what had been done and allowed the system to be taught, or directed it to be taught, in the schools of France.

The second enactment was by Napoleon the First, in the year 1812. In that it was stated that the system was making progress, but not rapid progress, among the people at large, and announced that a permissive system, giving some of the old names of the nearest metrical equivalents, should be allowed to be used, so as to permit a transition period.

The CHAIRMAN. That continued until the year 1840?

Mr. SUPLEE. No, sir; until the year 1837. In this book are given the full divisions at the time the law of 1837 was passed.

Mr, SHAFROTH. Did that compulsory act prescribe any penalty?

Mr. SUPLEE. Yes, sir; a fine of 20 francs was imposed for every offense, on any public officer using the old system, and a fine of 10 francs on any private individual so using it, the idea being, as suggested here, that the Government set a precedent. The whole details of that are given here in this work.

Mr. GAINES. By what vote was that act passed?

Mr. SUPLEE. I have it here somewhere, but can not find it just at this moment.

Mr. GAINES. Have it put into the testimony.

Mr. SUPLEE. Yes, sir. Since that time the metric system has been growing in France, and is in very general use now in those industries in which France predominates; that is to say, in their own work and in their own country.

One of the strong arguments offered in behalf of its adoption was the fact that in all the large departments of France, or in a great number of them, they were using measures of different lengths and values, but having the same name. For example, the foot in France was different in different parts of France. The Paris foot was different from the Norman foot, and so on; and the old pound was different. For the old French livre you had to say Paris pound, etc. There was consequently great confusion.

The same thing took place in Germany in 1872, after the war with France, when Germany became united; and then they found that all the different German States had feet of different lengths, varying in Prussia and Baden and Bavaria and Saxony and so on. None of them was willing to allow its foot to go out of use in preference to that of one of the other States, and so they took up the metric system. But nevertheless the old weights and measurements largely continue.

I bought a meter rule in Switzerland a few years ago. It had the millimeters marked on one side and the inches on the other side. I found upon examination that those were Swiss inches. The natives still use the Swiss inch in the country, among the common people, while among the scientific people the meter is used.

Mr. GAINES. You are over in Europe a good deal, are you not?

Mr. SUPLEE. I go over every year, very largely to keep in touch with what is going on. The Engineering Magazine, you know, is published simultaneously in New York and London, and it is my duty to keep posted as to what is going on.

Mr. GAINES. I understood you to say that in France, when this metric system was adopted, they had different lengths of the foot in different portions of France, and that when Germany extended her Empire each one of the provinces she absorbed had its particular foot, and none of those provinces wanted to give up its foot, and so they adopted a new system of measurement—the metric system.

Mr. SUPLEE. Yes, sir; that is correct. It would be practically the same if each one of the United States had a separate foot and pound; and naturally the confusion came about in that way. In the case of France, it took the French Revolution to overturn the old system and a great many other things besides; and it was considered a good time then to get rid of the old objectionable system of weights and measures. In Germany it came after the establishment of the Empire.

Mr. SHAFROTH. Do you not think it was a wise thing for both France and Germany to adopt the metric system?

Mr. SUPLEE. In France, as I said, it was adopted in 1837; in Germany in 1872, I believe—thirty or forty years ago.

Mr. SHAFROTH. Thirty-two years ago.

Mr. SUPLEE. Yes, sir. During that time there has been a tremendous change in Germany. At the time the metric system was adopted in Germany there was no interchangeable machinery, no standard

gauges, none of the system of manufacturing that has grown up here. In fact, they have only begun to have it within the last ten years.

Mr. GAINES. Would it not have been just equally well to have adopted the English system in France and Germany?

Mr. SUPLEE. Anything that would be uniform could have been adopted with equal indifference, so far as the objections to a confused or mixed system are concerned.

An example of that is the German money. The old German thaler was worth 75 cents. When they decided that they would adopt a new and uniform currency they decided to adopt the mark, nearly equivalent to the English shilling. On inquiry I found it was one-third of the old thaler, so that there would be no fraction in change over. They do not use the thaler now, but the mark. The mark ordinarily is counted as worth 24 cents of our money. It is not quite an English shilling. There is always a slight margin of exchange. They made it an aliquot part of the old money.

Now, nearly all the important obstacles to the use or adoption of the metric system have grown up since then—since the date of its adoption by Germany.

Mr. SHAFROTH. Do you regard it as wise for England to retain the old system of pounds, shillings, and pence?

Mr. SUPLEE. No, sir; I do not. I believe it is desirable to have a system of reckoning as to money based on the decimal system.

Mr. GAINES. You said just now the objections to the metric system have grown up in recent years.

Mr. SUPLEE. Yes, sir.

Mr. GAINES. What are those objections?

Mr. SUPLEE. Chiefly the amount of capital locked up in standard dies, gauges, tools, and other records——

Mr. GAINES. Which did not exist when France and Germany adopted the metric system?

Mr. SUPLEE. Only to a very slight extent. But in the past twenty-five years they have extended enormously. To-day the workman does not use a scale in calculus. He uses a gauge from the tool room. One of these gauges is a few thousandths large and the other is a few thousandths small. He must finish his work so that one of these goes on and one does not.

The CHAIRMAN. Who is the man that fixes that?

Mr. SUPLEE. He is the standard tool maker.

The CHAIRMAN. It would not be a very great hardship for him to determine the size he wanted in any system, would it?

Mr. SUPLEE. Oh, no; they could be made in the metric system perfectly well. But the point I make is that they are now made in the English system, and a change would be embarrassing.

The CHAIRMAN. Suppose he wanted to use it and wanted to work to a size given in the metric dimensions; he could easily adjust it to that size, could he not?

Mr. SUPLEE. No; they are not adjustable; they are fixed. As they are used they wear away. They are hardened and protected against the wear as much as possible. But it is his business to compare them as much as possible to fixed standards. If they were adjustable the workman could regulate them; he could alter them, and make them fit his work. But he can not do that; they are fixed gauges. Mr. Sell-

ers, I think, can tell you more about that than I can. In the tool room the mechanic can peen them together slightly with a hammer.

Now there are immense sums locked up in tools of that sort to-day. They could have been metric tools if the metric system had been adopted earlier. And that is what I mean by saying the greatest objections have grown up since Germany introduced the metric system.

The CHAIRMAN. They are what are called the smaller tools in the shops, are they not?

Mr. SUPLEE. Most of them are small.

Mr. SHAFROTH. If this vast amount of money were not invested in tools, and if this large business had not been developed, would you think it advisable to adopt the metric system?

Mr. SUPLEE. I do not see any particular advantage or any particular disadvantage in that case. It would be rather a question of both standing even. But now I think there is a decided disadvantage in adopting it.

The CHAIRMAN. Would there be any advantage growing out of having a universal system?

Mr. SUPLEE. Yes, that is a strong argument. It is desirable that there should be a universal system, but it is altogether immaterial what that system is.

Mr. SHAFROTH. Do you find any inclination on the part of foreign nations to adopt the English system?

Mr. SUPLEE. No, sir.

Mr. SHAFROTH. Do you know of any legislative body that has ever introduced a bill or that even proposed the English or American system for adoption?

Mr. SUPLEE. There has been no legislation, nor any effort of that sort that I know of, but there is to-day a very general tendency in metric-using countries toward the use of English measurements, and that is a practical violation of the law in metric-using countries. For instance, I was in the steam-engine works of Sulzer Brothers, at Winterthur, Switzerland, not long ago—an establishment famous for building the finest steam engines in the world, and they are built on the metric system with one exception. All the bolts and nut screws are in the English system. There are so many metric screw threads that it is impossible in any way to secure bolts and nuts to fit, and in this establishment the Whitworth system of screw threads, an English system, is used.

The CHAIRMAN. Do you know of any effort or any suggestion on the part of countries using the English system to go to the metric system?

Mr. SUPLEE. In bolts and nuts, you mean?

The CHAIRMAN. No; I am speaking generally.

Mr. SUPLEE. I do not know of any broad effort that has been made. You know, of course, of what is being done here. I know of some shops in England—as for example the works of Willans & Robinson, about which I wrote up some notes—that make their engines on the metric system. There would be no difficulty in making the gauges and templets, and so on, in the metric system. Another institution is the injector shop of Sellers & Co., of Philadelphia. In the year 1860 they purchased the French patent for that, and they thought it would be a good plan to install the metric system for that work, and they did so; and the injector shop of William Sellers & Co. to-day is run on

the metric system. That is one department of their works. That bears out what I said when I remarked before that it is easy to introduce either system if you start out with a clean sheet.

The CHAIRMAN. I am speaking of a general movement or agitation on the part of the countries using our system toward the adoption of the metric system.

Mr. SUPLEE. The only country that I know of that is using the English system as well as the metric system is Russia. About the year 1840 they had a lot of old measurements of their own, all mixed up, and then they began to use the English measures. The Russian foot is exactly like the English foot. An uncle of mine equipped the whole Russian railroad service with locomotives. The roadbed and the machinery and all were put under the English system and English measurements were used, but of late there has been shown a disposition on the part of the Russian Government to take up the subject talked of here, and I have no doubt the metric system is making headway there now.

Mr. SHAFROTH. Is it not optional in Russia?

Mr. SUPLEE. I think so.

Mr. GAINES. What did they use before?

Mr. SUPLEE. They had a lot of unpronounceable measurements in Russia, as numerous as flies.

Mr. SHAFROTH. When did they adopt the English system?

Mr. SUPLEE. I think about the year 1840.

Mr. GAINES. Please tell us about what England has done or is doing. There has been some argument here that a bill was pending in England, and that other bills would hereafter be introduced.

Mr. SUPLEE. There is no doubt that there is a considerable movement there, and among those who are agitating the question are many eminent scientific men—men like Lord Kelvin—physicists, chemists, men working in the laboratories. They are friendly to the metric system, and the whole electrical industry is friendly to the metric system. There is no doubt about that. Their whole system of units and measurements began anew in the electrical business. The Westinghouse establishment over there is a very large establishment.

Mr. GAINES. They are American people, who have gone there, are they not?

Mr. SUPLEE. The establishment is largely backed by British capital, but with American methods and machines. It is practically an American business transferred there.

Mr. BOWERSOCK. This is all very interesting, but I think we ought to wait until these gentlemen get through before we ask questions.

The CHAIRMAN. I think we had better let Mr. Suplee finish what he has to say first, and then we can propound questions.

Mr. SUPLEE. Well, then, the main point I want to make is this: I do not believe any system of weights and measures can be introduced with advantage by legislation. I believe there is only one way to do it properly, and that is by education. I am not particularly in favor of the metric system, and, on the other hand, I am not very strongly opposed to it, but I think if it is introduced, or if it is contemplated to introduce it, it should be allowed to grow up by process of evolution. It has to grow by teaching the children, and upon its merits, and not because it is pushed.

I think any attempt to enact such a bill as this, or, in fact, to enact any bill fixing a date or requiring the use of the metric sytem, either partly by the Government or by departments of the Government, would result in a period of confusion by the introduction of a converted system. You would be using a sort of hermaphroditic or bastard system—of both systems converted into one.

Here is an engineering handbook. There are several of this kind. In this handbook of mine I have taken the step of introducing a number of important tables, both in the metric system and in the English system. Those who want to use them should be educated to use them, and they should be used directly and not by conversion.

For instance, here is a table of weights of metals. Instead of using the metric equivalent of those, I give, facing them, the weight in kilograms of bar iron, etc. I do not attempt to transfer them one from the other. Here is another table, the steam table, giving the pressure, the volume, and the temperatures from one pound pressure up to a thousand pounds. Opposite that I give the French, or rather the metric steam tables, embracing the temperatures, volumes, and so on, in the units of the metric system. Each one stands on its own merits. If any one wants to use the metric system, he should be taught what a meter is by itself. Your measurements should be even, and the only way to bring that about is to teach the children to think in the metric system. Let the child have his blocks made in metric dimensions, and in his text-books the problems should be worked out, not by converting, but by separating them as wide as possible, and not attempting to convert them one from the other. It will then come upon its merits, and not otherwise.

I believe to-day that the progress of the metric system is represented largely by the progress of Germany, because Germany is a very progressive country nowadays. But the metric system has progressed because of its adoption by Germany, and not Germany because of her adoption of the metric system.

I think the inch, pound, ton, and foot of our measurements will persist so long as the industry and commerce and manufactures of the English people will persist, and any attempt to force another method upon them would be to force a conversion system.

I remember seeing, a few months ago, a very interesting photograph of Emperor William at the launching of the *Kaiser Wilhelm II.* He was standing on the platform, and at the sternpost of the steamer was a sign or placard containing figures indicating the draft of that vessel painted in English feet, because England is the leading country in shipbuilding, and these dimensions are given in feet—the displacement in tons, the draft in feet, the speed in knots, and so forth, in order to receive register at the Lloyds. The dog wags the tail, and not the tail the dog.

The CHAIRMAN. What do you mean by saying "registered at Lloyds?"

Mr. SUPLEE. The governing board at Lloyds, there, exact a large number of requirements. They do not accept the metric system there, and the vessels of the other countries desiring the advantages of being registered there are obliged to conform to their methods and the vessels are registered in the English system.

To my mind there is a very much exaggerated idea of the importance of any system as compared with the value of the industry behind it. I believe you will only make confusion by enacting legislation on this subject, and I believe education alone will allow the most important system to work out its own salvation.

There is but one other point that I should like to make, if you will pardon my doing it—because it is a rather delicate subject—and that is the impression very widely dissiminated in this country as regards the purport of this bill. There is a very widespread feeling that this bill is intended to be compulsory, without saying it expressly.

Mr. SHAFROTH. Is it not due to the fact that circulars have been sent out saying that?

Mr. SUPLEE. No; the fact that it is to be legalized makes many people think this is something else, and that there is, so to speak, "a nigger in the woodpile."

Mr. SHAFROTH. We have our system of money in dollars, but when we introduced that system we did not prohibit anybody from taking money in pounds.

Mr. SUPLEE. Then why do you omit the land laws, Mr. Shafroth?

Mr. SHAFROTH. Because the Government has already made its surveys according to that, and it ought to be continued so.

The CHAIRMAN. I think we should hear Mr. Suplee until he is through.

Mr. SUPLEE. I think I have said all that I intended to say in the limited time allotted to me. If I should have the privilege at some later time, possibly I could hand in some written communication, and that would be all right. Perhaps you have some questions to ask, gentlemen?

Mr. SHAFROTH. Referring to these remarks on the steamer you speak of, if England and America would adopt the metric system, that would all disappear, would it not?

Mr. SUPLEE. It could not disappear instantly, because the records for ships throughout the world are fully as great a matter as our own system would be. There would have to be a long period—a long transition per —first, with the metric system of measurement and the English yards both in use for a time.

Here in this bill I think you provide for two years, and possibly a shorter time—certainly one year—for the Government. That would certainly force a conversion system.

Mr. SHAFROTH. That is bound to occur when a change from any system to another is made.

Mr. SUPLEE. Not necessarily. I do not think any reasonable change can be made without a true change, and that can only be done by education.

Mr. SHAFROTH. Will not the confusion last longer where you have no law upon the subject?

Mr. SUPLEE. No; I do not think so. I think that, with all due respect to you as legislators, that government is best that governs the least.

Mr. SHAFROTH. Do you think there would have been uniformity in France, Switzerland, and Germany if they had not introduced the system by governmental agency?

Mr. SUPLEE. Oh, they are ruled in a certain way over there—in a way that would not be tolerated here. Their conditions are entirely

different from ours. Here the introduction should be natural and not artificial.

Mr. SHAFROTH. I believe that in time the metric system would predominate the world over; but it seems to me that legislation would aid it materially and prevent the confusion from being prolonged.

Mr. GAINES. Will you please tell this committee exactly what countries have the metric system and none other, and then those countries that have the metric system and some other, and tabulate that data at your convenience and put it in your testimony?

Mr. SUPLEE. I can do so, but I do not think it is necessary.

The CHAIRMAN. Do you think, Mr. Gaines, there is any nation in the world that does it—that uses the metric system and absolutely none other?

Mr. GAINES. I want to get all the facts and form my opinion on them.

The CHAIRMAN. But your question would be obviously answered by the statement Mr. Suplee has made. There is no such country. I thought perhaps you had not expressed your idea correctly.

Mr. SUPLEE. This has already been fully done. Just before I came here I saw Mr. Halsey's book. Mr. Halsey is a friend of mine. He has given an elaborate list of just such countries.

Mr. GAINES. That is substantially correct?

Mr. SUPLEE. I think so. Of course I can not vouch for all these points.

Mr. GAINES. Can you tell us why we should change our system for the metric system?

Mr. SUPLEE. I do not know why. I use the metric system myself for some matters and the English system for others. I think it should be entirely open to individual preference.

The CHAIRMAN. If we could have one system of weights and measures in use throughout the whole world what would be the advantages accruing from such a situation?

Mr. SUPLEE. It would depend largely upon what the system was, in connection with what had preceded it. If we had always had one system from the beginning, the advantages would be enormous, undoubtedly; but as we have not had one, it is inevitably tied up with what preceded it, and it is impossible to advise as to the future from the past. If you could wipe out or wipe off the slate entirely, I would say, Go ahead at once and make the adoption of the metric system compulsory.

Mr. SHAFROTH. The metric system?

Mr. SUPLEE. Yes. Make it uniform all over the world. Its disadvantages would be immaterial then; but you can not do that now. It is too late.

Mr. SHAFROTH. Do you believe we could ever have adopted our system of money without a compulsory law, or without legislation? Do you not think we would be adhering still to the English system?

Mr. SUPLEE. Yes; perhaps so.

Mr. GAINES. I have heard the gentleman from Colorado say, time and again, that the reason Thomas Jefferson took the silver dollar as the unit was because it was already here and the people knew all about it.

Mr. SHAFROTH. No; I think as a matter of fact that our silver dollar was established from the Spanish dollar. It had come here, but the English money was also here, and we had it to a certain extent. It circulated because of our laws. Our laws were passed to the effect that the Spanish dollar should be a legal tender.

Mr. SUPLEE. Only a portion of the English money was in circulation here—the lower denominations of the English coinage, I think—the shilling. I do not think that pounds sterling ever circulated here to any considerable extent as coin. In land transactions the values were expressed in pounds. I have some old English deeds which I have inherited from my ancestors, and they show that fact.

The CHAIRMAN. If the Government should adopt one system of weights and measures and not another, the adoption would facilitate that system, would it not?

Mr. SUPLEE. Of course; but I think it is impossible to get rid of the idea of the fact that we can not abandon the records, the standards, and details we have, as a whole. We have got to interweave them and keep what we have and get what we can. Any attempt to do that, otherwise than by education running over a period of years—say from childhood to manhood—would result in the introduction of a bastard system.

The CHAIRMAN. Suppose a Department of the Government was using two systems of weights and measures; do you think it would be of advantage to that Department of the Government to secure uniformity of weights and measures there?

Mr. SHAFROTH. I beg pardon; to what?

The CHAIRMAN. Supposing that any Department of the Government, say the Surgeon-General's Department of the Navy or of the Army, was using two systems of weights and measures in its work; can you imagine that it might be of advantage to that Department to secure uniformity in the weights and measures which it uses?

Mr. SUPLEE. It might be of advantage for them to use in their own work only one system; but it would not be of an advantage to them, I think, to attempt to use only one in connection with the outside world, in which the other system was also in use. For instance, they might send out orders for materials in the metric system and buy them from a house which handles them in the English system. It would be better for them to order in the English system in such a case. In other words, it depends again upon the use that is made of it.

The CHAIRMAN. I understand that the Medical Department of the Navy gives all of its orders in the metric system.

Mr. GAINES. Who testified as to that, Mr. Chairman?

The CHAIRMAN. The Surgeon-General did.

Mr. SUPLEE. An example, Mr. Southard, that might bear on this subject is this: The apothecaries and nearly every drug clerk who puts up prescriptions are expected and practically required to know both the metric system and the old apothecary's measure, because nearly all physicians write in the metric system, and a mistake might be fatal. It takes the greatest care, and yet these two systems are used right side by side.

The CHAIRMAN. Is your objection founded upon the difficulty of learning the metric system?

Mr. SUPLEE. No; upon the difficulty of using it. A large number of units and measurements which are largely obsolete in the English

system are employed for exhibition purposes to swell the apparent volume of objectionable ones and to make it appear that our present system is more cumbersome than it really is. I use the cubic foot, and tenths and hundredths of a cubic foot, up and down.

The CHAIRMAN. Do you know how many cubic inches there would be in a cubic foot?

Mr. SUPLEE. Nearly.

The CHAIRMAN. And do you know how many cubic feet there are in a cubic yard?

Mr. SUPLEE. Yes, sir.

The CHAIRMAN. And what is that—thirty and a fraction?

Mr. SUPLEE. No; 27.

The CHAIRMAN. In our square measure these ratios would be somewhat difficult to remember, would they not?

Mr. SUPLEE. No; I have very little difficulty in remembering them, but there are a vast number that I do not use at all. I very rarely put pencil to paper. I make my calculations mentally.

The CHAIRMAN. For instance, the square yard or the square perch or pole?

Mr. SUPLEE. Those are dropping out. An engineer no longer uses the 66-foot chain.

Mr. SHAFROTH. Is the rod often used nowadays by people talking about distances?

Mr. SUPLEE. No; I do not think it is. It is used in sports and games very largely. Sprinters use it. The engineers do not use it much any more. They use but very few measurements. The old idea of flowing water used to be in gallons. Now it is in cubic feet invariably. So in a machine shop the inch is used and its decimal subdivisions.

The CHAIRMAN. Some people have said that advantages accrue to our system by its lending itself to binomial subdivisions.

Mr. SUPLEE. Yes, sir.

Mr. GAINES. We have improved the English system?

Mr. SUPLEE. Yes; and that has been done without any legislation whatever.

Mr. GAINES. One more question, and then I am done. I base it on Mr. McFarland's statement on page 45 of the hearings had by this committee in 1902, where he said:

> After long experience with men working on both systems, he [our chief engineer] found that men brought up on the decimal system abroad, when working in an American drafting room, will work more rapidly when using the English system than the decimal system.

Now, what is your observation and experience as to that?

Mr. SUPLEE. That depends on the man in planning and drawing and laying out work. The binomial system is better than the metric system, if you are using or creating a dimension, as you would practically do in designing. The binomial subdivisions in that case would undoubtedly be the best. If you are computing after it is made, the decimal system would be the best. But I believe the one great disadvantage that would result from the adoption of the metric system would be to fasten upon us the decimal system, which I think is by no means the best.

Mr. SHAFROTH. Do you think the duodecimal system is the best?

Mr. SUPLEE. No; I think the graduated divisions of scales, based on an entirely new system of numeration, would be the best. In such

a system multiplication would be division, and addition would be subtraction. That would be some time coming, but I think it would be preferred.

I once saw a calculation worked out under the old Roman system of numbers. It was a brain-splitter, and a modern child could state it in a few lines. I believe that eventually a system will be devised that will be as superior to our present system as our present system is to the old Roman system.

STATEMENT OF MR. ERNEST F. DU BRUL, OF CINCINNATI.

The CHAIRMAN. Mr. Du Brul, please state whom you represent?

Mr. DU BRUL. I am here, gentlemen, in a sort of treble capacity. I am a manufacturer primarily and an American engineer, and I am also here as representing the National Metal Trades Association. The National Metal Trades Association is an organization of metal trades manufacturers, engaged in the production of machinery and boilers, brass work, patterns, and other products of metal working—very largely machinery.

In the national organization we have some 325 firms, employing directly about 40,000 operatives; and with our affiliated local branches I suppose we could count on about a thousand firms, all told, including the national membership, and about 75,000 operatives.

The association took a vote on this bill. We have carefully considered the bill in its present form. We considered that at our last convention and likewise considered the bill that was up at the previous Congress, some two years ago, and the overwhelming sentiment of the membership, both as expressed in convention and by a main vote, was against the adoption of this bill in its present form; and practically the sentiment of the association, overwhelmingly shown, is against any attempt in any manner to do anything more with the metric system than has been done with it heretofore, and if there is any merit in the system, simply to let the system win on its own merits.

The point raised by Mr. Suplee is the prime reason of our objection to this bill, namely, the confusion that would result. There may have been a time when we could have adopted, even in purely Government work, the metric system, without creating considerable difficulty. But we feel that that time has gone, because there have been literally millions and millions of dollars locked up in measurements in our shops, to say nothing of the tremendous aggregation of shops outside of our organization. We have, through all our representatives, probably only one-fifteenth or one-twentieth of the machinery manufacturing interest of the country. Perhaps of the total capital represented we have even less. So that, if it means millions to us, what does it mean to the whole industry?

Now, it has been said at some of these hearings, and by some of the advocates of the bill as it stands, that this does not affect the manufacturer. I am speaking as a manufacturer to show you how it does affect us. The question raised by the chairman a while ago—I tried to take it down—one question there was, "If we could have one system in general use all over the world, would it be a good thing?" That, gentlemen, is absolutely beside this proposition. I think, if we could have it, it would be a good thing. But we can not have it, and what is the

use of talking about it? If we could have it all over the world it would doubtless be a good thing; but these people will not give up their things. If we could have a universal monetary system all over the world it would be a good thing; and I think it would be far easier and more practicable to have a uniform monetary system than a uniform system of weights and measures, because there is not such an amount of fixed capital locked up in a circulating medium as the amount of capital there is in this country locked up in the way of fixed measurements.

You have made an exception here in the case of the survey of the public lands, because your measurements of the public lands are tied up in this record. You evidently realize the amount of confusion that would come to the Government's Land Department by a change of those records. We want the gentlemen of this committee to be impressed with the fact that there are more millions of money tied up in our shops in measurements than your Government Land Department could ever conceive of.

Mr. SHAFROTH. Is it not a fact, however, that if we postpone it twenty-five years and then adopt it, the condition will be worse then than now?

Mr. DU BRUL. Yes; but why need we adopt the metric system at all?

Mr. SHAFROTH. You say let one by superiority counteract the other.

Mr. DU BRUL. As long as you have no compulsion about it it will not. In the period of transition it will become, as Mr. Suplee has called it, a conversion system, a bastard system. It is neither fish, flesh, nor fowl, nor good red herring. If we are going to have a metric system, let us have it, and not a conversion from one to the other, which is confusion worse confounded. The question and the difficulty with us is the confusion which would ensue.

A point has been raised that all the other countries that adopted the metric system, as has been so well set forth by Mr. Suplee, had confusion before its adoption and tried to secure uniformity by adopting the metric system. It has been an advantage to them; but to us it would be a disadvantage, because it would introduce a confusion that we do not now have. That is the great point.

Now, the matter of conversion has been touched on by Mr. Suplee, and I agree with him thoroughly. If we are going to have a system, let us have a system and not a mixture—the idea of a system abstractly being something systematic and logical. A mixture, however, by conversion is neither systematic nor logical, and therefore it can not be called a system.

The thing in this proposition that tends to alarm our members and every workingman in the country, as I take it, is that this bill is only a step looking to the final adoption of the metric system all over the country; and every workingman in the country will have to buy new tools, and every machine shop will have to introduce new tools and machinery, according to the bill as it stands, the Government specifying metric measurements.

Take the Navy Department. In its shipbuilding it uses the standard structural shapes, standard structural plates, standard material of all different sorts. The Government did not establish those standards. Those standards, which are just as much standards for that sort of

work as your meter or your foot or standards of length, were adopted by consent and necessity on the part of the manufacturers of those things. They were not mere matters of chance. They were the result of expensive tests and of the expenditure of thousands on thousands of dollars dedicated by societies or associations of these manufacturers for certain purposes.

As an illustration, the ice-machine manufacturers have recently been conducting an experimental test to determine a unit of refrigeration. That is a standard or measure, just as much as a meter, or a liter, or a pound, or a foot. The standards of structural shapes are decided on, as I say, after long and exhaustive tests to produce the best results with the minimum of material. These things are inevitably fixed in the rolling mills of the country, and if the Navy Department goes to specify those things the way they are they will not be using the metric system

Mr. SHAFROTH. In expressing the materials of a ship, do they indicate the sizes?

Mr. DU BRUL. They simply specify the material they want; perhaps not in a contract. Then they practically tell the contractor, "You furnish certain results," and guarantee certain results.

Mr. SHAFROTH. Are not battle ships all bought in this country?

Mr. DU BRUL. Oh, no; the Government has built a number of battle ships, and they are making their own repairs. In the Brooklyn Navy-Yard, in the Mare Island Navy-Yard, and at the Norfolk Navy-Yard they are building ships and buying standard material there.

Mr. SHAFROTH. Do you suppose this bill would prohibit them from buying standard material?

Mr. DU BRUL. They would not be buying metric materials. They would not be using the metric system in all business requiring weight and measurement. You would not be using the metric system on that proposition if you bought the material the way you find it. You are not buying metric material.

Mr. SHAFROTH. Could you not resolve all these things into the metric system?

Mr. DU BRUL. You could convert them. But there you come back to the conversion proposition. You have the conversion tables; but then you go to a bastard system instead of the pure metric system. In other words, you will be using a conversion. You will order a structural material which to-day is made to sustain so many pounds weight per running foot. What will you order? If you specify it in the metric system, you will order so many kilograms, decimal, decimal point, dash, blank! [Laughter.] That is about the size of it. You will have confusion right there in the Navy Department and in the other Government Departments.

Now, there will be expense to that confusion in the Government, if the confusion is in a Government department only. If they simply order in their equivalents, it will be an unnecessary expense in the department, and that unnecessary expense will be borne by the taxpayers of the country. If on the other hand the Government adopts the pure metric system proposition, the expense is transferred to private shops, and in this way, that they will then have to take a certain amount of their equipment in metric measures. If the Government orders materials in the metric equivalents of the present standards, the

manufacturers will have to duplicate all of their tools, because all of them being in inches their tools would have to be duplicated in metric measurements, and the Government would in the end have to pay the bill, because the manufacturer would not put in that equipment unless paid for it. In other words, the whole country would have to pay for it, as pointed out in a report made to the American Society of Mechanical Engineers, on page 708 of the committee report on the metric system, where it says:

The acknowledged compulsory feature of the bill, namely, that the Government must use the metric system (except in the public land surveys) means that all measurements in contracts entered into by private citizens for Government work shall be expressed in terms of the metric units. This would cause existing standard sizes to be expressed in equivalent metric terms, with the resulting inconvenience and confusion, or else new specifications, drawings, patterns, gauges, etc., must be prepared to accommodate the sizes to convenient exact metric dimensions. This evidently involves the abandonment of existing standards, a matter of serious importance, especially in the Navy Department.

If any confusion exists in our English system from having too many units of length, weight, and volume, the confusion would only be added to by having the Government use a different system of measurement from the rest of the people.

Mr. GAINES. What is the date of that report?

Mr. DU BRUL. The date of this editorial which I have read is March 20, 1903.

Mr. GAINES. No; the date of that report?

Mr. DU BRUL. It was submitted to the American Society of Mechanical Engineers some time in the spring of 1903.

The CHAIRMAN. What was done with that report?

Mr. DU BRUL. I believe the society took no action, except an informal mail ballot shows an overwhelming opposition to features of the bill, in accordance with this report.

The CHAIRMAN. Do you not think that the American engineers themselves have and had the same impression in regard to this bill as was stated by Mr. Suplee, who preceded you? I mean have they not the idea that in its general provisions, and as applying to the general public, it is a compulsory measure?

Mr. DU BRUL. They perhaps have that idea; and stlll this report is very specific, and this editorial is specific in referring to the bill only in regard to Government work.

The CHAIRMAN. Do you not think the general impression prevailed, in consequence of the questions they submitted to the membership of their association, that this bill, this pending legislation, is intended to be compulsory as applied to the general public?

Mr. DU BRUL. I do not think our membership took that view, Mr. Chairman. I think that they feel, many of them, that they are Government contractors for machinery, and they are opposed to the bill on account of its creating a divergence of standards between them and their customers.

The CHAIRMAN. I ask that question because I have received numerous letters which indicate to me that that impression prevails. Most all the letters characterize the bill as a compulsory metric-system bill, using the word "compulsory."

Mr. DU BRUL. It is compulsory on the Government.

The CHAIRMAN. But those letters spoke of it generally as a "compulsory" metric-system bill.

Mr. DU BRUL. We are opposed to the matter as it stands in relation to Department work because so many of our manufacturers are doing Government work.

Mr. GAINES. Do you oppose it because it is compulsory or because it will change to the metric system?

Mr. DU BRUL. We are opposing it because of the confusion we think it will bring into the shops—confusion which does not exist to-day.

There is a further paragraph here which says:

> The pending bill simply aims to make it commercially advantageous for manufacturers dealing with the United States Government after a certain date to supply articles made to metric measurements. Is there any hardship in that? [a]

Again, let me read from Appendix XIX of the same report, concerning "Compulsory legislation," at the bottom of page 710:

> Why should Congress pass a law, not demanded by the Departments or by the people, which will give the Government and those who deal with the Government so much trouble, with no compensating advantage whatever? Merely because the metric advocates, a very small fraction of the people, who have been conducting a metric propaganda for thirty years, wish the Government to undertake the education of the people in a system of weights and measures which the people do not want. They wish, as they say, to "try it on the dog."

In other words, the Government will have to pay more money for its machinery, and the manufacturer who will be in shape to go into the metric part of the business will have an equipment paid for by the Government, whereas to-day he is paying for the equipment himself.

Mr. SHAFROTH. Do not a great many manufacturers now manufacture machinery both in the metric system and in the English system?

Mr. DU BRUL. I know of only two metric shops—one is that injector shop of William Sellers & Co., in Philadelphia, which Mr. Suplee spoke of, and the other is a shop in Chicago which is building a Swedish ice machine. They got all their drawings from Sweden, although their bolts and nuts were English, and they started off as a new proposition on the metric system. They had to bear the expense of conversion. They had all their drawings, and patterns, and templets, and so on brought over from Sweden, and they went right along on the old measurements, thus showing that the measurement is absolutely and inevitably tied to the product. If the matter had been a simple proposition they would not have redesigned; they would have made equivalent metric measurements.

In our own case we had some drawings of a French machine in metric measurements, and we practically bought the design of the machine from a French engineer, and rather than go on with his metric measurements we went to an expense of about $2,000 upon that one machine, to redesign the thing, practically, and throw away all his distances and scales and things.

Mr. GAINES. What firm do you belong to?

Mr. DU BRUL. To the Miller, Du Brul & Peters Manufacturing Company, of Cincinnati, Ohio.

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[a] The pending bill simply aims to make it commercially disadvantageous for manufacturers who do not wish to provide the equipment necessary to supply articles made to metric measurements. Is not this a hardship?—W. K.

The CHAIRMAN. Ordinarily for a comparatively light expense a machine can be changed so as to turn out its product in metric measurements, can it not?

Mr. DE BRUL. Yes; we do that on a cigarette machine. As has been stated to the committee before, as I understand, the French Government has a tobacco monopoly, and they buy cigarette machines. We have a machine which they like. They wanted us to build that machine for them metrically, so that they could make repairs and handle the matter easily in their own shops after they got the machine over there; but their orders would not justify it. We told them what it would cost to have it that way—that on the very first order they would have to pay for the new set of drawings. They did not want to do that, but with a very slight change in the machine we could make the metric cigarettes.

Mr. SHAFROTH. Without any additional cost?

Mr. DU BRUL. Without much additional cost; simply a change in the gearing on the machine. But the machine is not a metric machine; it is an American machine. The point is just here: We would not and could not make a metric machine at the price. It would have required a full set of the gauges that Mr. Suplee has talked about. It would have required a new equipment of twister drills, and so on.

Mr. SHAFROTH. If you had once made the tools it would have been an equal expense to go back from the metric to the English system?

Mr. DU BRUL. Yes, sir.

Mr. GAINES. How many orders have you filled for this French company?

Mr. DU BRUL. Oh, I suppose ten or fifteen orders.

Mr. GAINES. This order, now, was—what did you say?

Mr. DU BRUL. For a cigarette machine.

The CHAIRMAN. There is no trouble about getting twister drills?

Mr. DU BRUL. No; but we would have to lock up that much extra capital in a double equipment of tools. The only change we had to make in that machine was simply in the gearing.

Mr. SHAFROTH. Could you not use the old machine until it wore out, and then make the transition to the new machine, and go on with it?

Mr. DU BRUL. No; we would have to have a new machine at once.

Mr. SHAFROTH. But could you not use the old machine for trade purposes until it wore out?

Mr. DU BRUL. Yes; we would still have to keep our inch equipment and thousands of dollars' worth of tools, and gauges, and patterns, and drawings in order to provide for future repairs.

Take the question of piping—the standard thread of a pipe. Supposing you bought chandeliers with American measurements and you can not tear out the piping in a building—it is all in feet and inches and your pipe up there has a standard inch thread and you have got to put on an extra nipple at an extra expense. You have got to put on a double nipple there with metric threads and inch threads, and vice versa. You take another chandelier out from another room and bring it in here, and if your pipe is metric you must put on thread half metric and half inch.

The CHAIRMAN. Why is there any necessity of changing that system until a new system of screw threads should be adopted, if one should be adopted?

Mr. DU BRUL. You never could get a new screw thread in a pipe that is embedded in a ceiling.

The CHAIRMAN. That screw thread being the standard, what would be the necessity of changing it until some new standard was adopted? I know there are a number of standards of screw threads; but, as I say, until some new standard, generally adopted by the trade, should come in, what would be the necessity of changing that screw thread?

Mr. DU BRUL. New chandeliers, for instance, might be made on the new standard, and your old system of piping——

The CHAIRMAN. I am not talking about the chandelier, but about the screw thread. You would not make one by the one standard and the other by the other and expect them to fit?

Mr. DU BRUL. Of course not. If you have an inch standard screw thread your screw thread will depend upon the size of the pipe that you use. If that is on the inch standard and you are using the metric standard somewhere else, it would compel you to let the old standard remain as well as to introduce the new standard.

The CHAIRMAN. Would you be obliged to adopt the metric equivalent?

Mr. DU BRUL. Yes, sir; which is a confusion against which we are objecting strongly.

Mr. SHAFROTH. Are the screw threads used for chandeliers the same?

Mr. DU BRUL. They are practically standard.

Mr. SHAFROTH. How long? How long have they been used?

Mr. DU BRUL. I am not familiar with that branch of engineering.

Mr. SHAFROTH. Have they been used about ten years?

Mr. DU BRUL. I do not know.

Mr. SUPLEE. I think it is about twenty or twenty-eight years.

Mr. DRESSER. The expense of that little nipple there, changing the metric thread on the one hand and the standard thread on the other, would be very nominal indeed, I think.

Mr. DU BRUL. That is very true; but you have got to incur the expense of double equipment for the man who wants to make that nipple.

Mr. GAINES. And you have got to make that nipple?

Mr. DU BRUL. Yes, of course. And if you have had any experience with a plumber in your house you will know that he is always forgetting something, and every little detail in his work increases the confusion, and it is already intricate enough, and it is that confusion that I want to avoid. We already have uniformity, and we want to keep it.

Mr. GAINES. You want to stand pat?

Mr. DU BRUL. Yes; let us stand pat. [Laughter.]

The CHAIRMAN. What is the size of the ordinary inch pipe? Is it an inch?

Mr. DU BRUL. It is supposed to be an inch.

Mr. DRESSER. You mean the inside diameter.

The CHAIRMAN. Do you measure by inside or by outside diameter?

Mr. SUPLEE. Inside diameter for gaslight and water pipes and outside diameter in the case of boiler pipes.

The CHAIRMAN. What is the size of the ordinary inch pipe?

Mr. DU BRUL. It does not correspond to the inch, as a rule. It is not made to such close limits. It is not rolled to the thousandth part of an inch.

The CHAIRMAN. Or anything like it?

Mr. DU BRUL. No; they do not attempt to.

The CHAIRMAN. What I mean is that the screw thread is not anything that involves a very close measurement.

Mr. DU BRUL. It depends on the sort of work you are doing with it.

The CHAIRMAN. I mean ordinarily.

Mr. DU BRUL. It involves a measurement so close that the metric threads would not fit on an inch pipe. It would tear out if you tried to put it on.

The CHAIRMAN. But it would not be hard to get an approximation expressed in millimeters, would it?

Mr. DU BRUL. You would get the approximation, but the approximation would be confusion.

The CHAIRMAN. But there would be no difficulty about it?

Mr. DU BRUL. Oh, no.

The CHAIRMAN. Is it not true that for some years there have been suggestions of a new standard of screw thread, a finer thread than is now in use?

Mr. DU BRUL. That is not intended to take the place of the present thread, but it is to be used for a different kind of work than the present thread is used for.

The CHAIRMAN. And, as a matter of fact, there are already in existence several standards of screw threads?

Mr. DU BRUL. Yes; for different classes of work.

The CHAIRMAN. And that in itself results in some confusion?

Mr. DU BRUL. I do not think so. But there is some confusion in this way, and this illustrates just what a small thing can do to create confusion. The V thread and the United States standard thread are closely similar, but one is truncated and the other is sharp. Mr. Lodge, of the Lodge & Shipley Co., is vice-president of the National Machine Builders' Association—and, by the way, he wants to appear here when opportunity presents itself—and this Mr. Lodge told me the other day, as an instance of what a change meant, that years ago they began building their machines with V threads, and then the Sellers thread was practically made standard by the United States Government; and the Lodge & Shipley Co. decided, two years ago, that they had better, for the benefit of their customers, change from the V thread to the standard thread.

The CHAIRMAN. Is that the Whitworth thread?

Mr. DU BRUL. No; that is the Whitworth standard—another standard. They are still in confusion over that, and they have been at it—I mean the Lodge & Shipley Company have been at it—for two years now, and they have tried to put the United States standard threads on their new machines, and they are still in confusion, and have to carry double stocks, with all of their attendant annoyances, and sometimes the stock keeper will deal out V threads when he should deal out the United States standard threads, and sometimes standard threads when he should deal out the V threads; and of course that makes confusion.

The CHAIRMAN. Is it not true also that certain manufacturers, in order to preserve or secure to themselves the opportunity to make repairs on the product which they themselves turn out, adopt a particular screw-thread of their own?

Mr. DU BRUL. Yes, that is done; but I think that practice is disappearing very largely. The modern practice is to conform to the standard, so that repairs can be made with ease. That other method is a very short-sighted Chinese policy.

The CHAIRMAN. You have the Whitworth standard, and the United States standard, and other standards, and they do not correspond with each other?

Mr. DU BRUL. The Whitworth standard is not very largely used in this country.

The CHAIRMAN. We use the United States standard?

Mr. DU BRUL. Yes, sir.

The CHAIRMAN. When we send machinery abroad, of course that secures to us the opportunity, I will say, to a certain extent.

Mr. SHAFROTH. A monopoly of repair.

The CHAIRMAN. To a certain extent a monopoly of repair.

Mr. DU BRUL. It provides a market abroad for American screws.

The CHAIRMAN. And to that extent it must be unsatisfactory to the people abroad?

Mr. DU BRUL. To that extent I should judge it would be. Still, they, having no metric standards of screw threads, might as well have ours.

The CHAIRMAN. Is it not a fact that the Whitworth standard of screw threads is used largely abroad?

Mr. DU BRUL. Yes; in Germany, France, and practically other countries. Now, I think I have covered about all the points I had in mind to make.

Mr. GAINES. Is the Whitworth standard screw thread a different standard from ours? How similar are they?

Mr. SUPLEE. The Whitworth standard (English) is 55 degrees, and the American standard is 60 degrees. The Whitworth standard is round at the top and bottom, and the American standard is flat.

The CHAIRMAN. Gentleman, the hour has arrived for adjournment. Unless there is some reason to prevent, the Committee will reassemble one week from to-day.

Thereupon, at 12.15 p. m., the committee adjourned.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., February 4, 1904.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

STATEMENT OF WILLIAM J. WARRENER, OF FEDERAL, OHIO.

The CHAIRMAN. Mr. Warrener, I believe you have been waiting a week for the committee.

Mr. WARRENER. Yes, sir.

The CHAIRMAN. We have an hour and a quarter that we can devote to this hearing, and I would like to divide it up between you, Mr.

Sellers, and Mr. Towne. Will twenty minutes be sufficient for you this morning?

Mr. WARRENER. I think it is very likely it will.

I have prepared a diagram, which I have here, to illustrate part of my remarks.

The CHAIRMAN. I do not believe it will be possible to print those diagrams.

Mr. WARRENER. Very well. I do not ask that, sir.

The CHAIRMAN. It is something like we have here.

Mr. WARRENER. Only it illustrates the British system instead of the metric system, and shows that it is on the same scientific basis, really, as the other.

I wish, first of all, to read the resolutions of the grange to which I belong on this subject, and say that F. A. Derthick, delegate from Ohio, master of the Ohio State Grange, offered those resolutions to the National Grange protesting against the adoption of the metric system of weights and measures. He said that Ohio was dead against the innovation and much preferred the old-fashioned system:

At a meeting of the Amesville Grange, No. 798, P. of H., held October 24, 1903, the following was adopted and a copy ordered sent to F. A. Derthick, master of the State Grange of Ohio, with a request that he present the same to the National Grange at its coming session:

Whereas at the last session of Congress a bill was introduced in the House of Representatives to make the metric system of weights and measures compulsory in all the Departments of the Government after 1904 and to make it the only legal system in the United States after 1907, but which was withdrawn because of lack of time to consider it; and

Whereas it is the intention to reintroduce the bill at the next regular session of Congress, or so much of the bill as will make the system compulsory on the Departments of the Government, we, the members of Amesville Grange, No. 798, P. of H., Amesville, Ohio, respectfully request the National Grange of Patrons of Husbandry to enter its protest against the passage of such a measure.

In our opinion it would be absurd for the Government to insist on the use of a system of weights and measures in all its Departments, and that one new to our people and not in general use by them, and which would involve persons having dealings with the Government in trouble and expense that is totally unnecessary, also entail upon the Government great expenditure for no useful or necessary purpose. A change in our weights and measures is a thing that should not be done unless for some very strong reasons indeed. Our present system of weights and measures is understood by our people, they are familiar with its nomenclature, and they think in its terms; and, if any change at all were made, it should be by way of improving it instead of introducing another system that is in every way incommensurate with it.

The experience of other countries whose governments have adopted the metric system and endeavored by the most drastic legislation to compel the people to use it, and it only, should be a warning to us against similar attempts, for it shows that its only result is that confusion becomes worse confounded by simply adding one more system to those already in use. That the system itself is inadequate to the everyday needs of the people is proven by the many modifications of the system where it is used; by the doubling and halving and dividing by three, and the giving of other names than the names that form an essental part of it.

No such condition of affairs exists in this country to-day as existed in European countries when they adopted the metric system. The inch, foot, and yard are the same everywhere throughout the United States and the British Empire; so are the avoirdupois ounce and pound in use by the masses of the people in their everyday transactions. The measures of capacity, too, are well known. Our land has been surveyed and the records of measurement given in acres and fractions thereof understood by all.

Our system of weights and measures has come to us as the result of ages of experience in measuring and weighing and calculating, and, as was shown by John Quincy Adams in his famous report to Congress made February 22, 1821,

it is founded in nature, while the metric system, made by theorists, is based on a mistaken measurement of the earth, and is not, therefore, in any sense natural, except, perhaps, in its system of decimals, which is not always an advantage in counting, and is decidedly inferior in measuring and weighing.

E. H. BRAWLEY, *Master.*
S. R. MCCUNE, *Secretary.*

Mr. WARRENER. The bill is intended to make the metric system compulsory in Government Departments first and later on "the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States."

The bill rejected April 7, 1896, had "the only legal system of weights and measures recognized in the United States."

The bill of 1903 omitted "only." Now it is changed to "the legal system."

Attorney-General Knox is said to have declared: "There is nothing in this bill of a compulsory character except as to the Departments of the Government." But on page 56 of these hearings we find this:

Mr. SHAFROTH. * * * We have a mandatory voice as against the officers of the Government, and we have not a mandatory voice on the people. We can not say that the people shall use this. We have no authority to do it. They have a right to do what they please. We can say when they testify in court that the testimony shall be in this system, and that will tend to make them familiar with it, and we think also it would tend to that if the Government officers would adopt this system.

That means just what the word "the" in the bill means, viz, that the system now in common use would be outlawed. The metric system is a legal system now in the United States. It has been since July 28, 1866. This will be a useless piece of legislation if it does not change the legal status of the two systems, and, in the opinion of the majority of people, an unwise and pernicious one if it does.

The suggestion that the people shall become familiar with the system by testimony in courts of law is of ill omen. It means that the system will be productive of lawsuits, and that is what the people wish to avoid.

The metric system for universal use in weighing and measuring is unnatural, and therefore unscientific and impractical. It is not by any means a perfect system, is not superior to or an improvement on the system in common use among our people, which metric advocates seek to displace by it.

Two things are essential to it: Its decimal divisions and its nomenclature. Some of its advocates go further and insist on its peculiar orthography. It will be generally conceded that its dimensions are fixed. Like the laws of the Medes and Persians, they are unalterable. The base of the system is the meter, supposed to be the ten-millionth part of a quadrant of the earth. Its length is given in Chambers's Encyclopedia as 39.3707904 inches; in the World Almanac as, in England, 39.37079 inches; in France and Germany, 39.370432 inches.

This length was obtained by measuring part of the distance from the equator to the pole on the meridian of Paris, estimating or guessing the unmeasured part, adding the whole together, and dividing the result by 10,000,000. Subsequent calculations were said to show that the first estimate was too short, and that consequently the

meter, instead of being correct meter, is short meter. It was supposed that all quadrants of the earth were of the same length, so the meter would be common meter; but from surveys and estimates made during the last hundred years it seems that no two quadrants are of the same length, so the meter is not common meter, but peculiar meter. The polar diameter is, of course, a fixed length, yet, as showing the liability to err in calculation, the results of several are given in volume 7 of the United States Coast and Geodetic Survey, as follows. The lengths are given in meters, which I have converted into inches by using the rule there given:

Bessel, 1841: From 10 arcs of the meridian, polar semidiameter in meters, 6,356,079, or 250,241,575 inches.

Clarke, 1858: Special sphereoid for surface of Great Britain and Ireland, 6,355,746 meters, or 250,228,465 inches.

Clarke, 1866: From 5 meridional arcs, 6,356,584 meters, or 250,261,457 inches.

Clarke, 1880: From 5 meridional arcs and longitudinal measures, 6,356,515 meters, or 250,258,741 inches.

Harkness, 1891: From "The solar parallax and related constants," 6,356,727 meters, or 250,276,087 inches.

United States Coast and Geodetic Survey, 1900: Eastern oblique arc of the United States, 6,357,210 meters, or 250,286,103 inches.

NOTE.—For conversion of English feet into inches Clarke's determination of 1866 was used, viz: 1 foot = 0.30479727 meter; 1 meter = 3.28086933 feet.

These estimates vary from 250,228,465 inches to 250,286,103 inches. An average taken from the highest and lowest estimate would be 250,261,457 inches. The last two estimates give the greatest length. Sir John Herschell thought that the length was about 250,250,000 inches, and said, when discussing a measurement of the earth as a basis for a system of weights and measures:

So long as the human mind continues to be human and retains a power of geometry, so long will the diameter be thought of more primary importance than the circumference of a circle—

and that to choose a certain proportion of the quadrant instead of the diameter for a meteorological base—

was not a blunder only; it was a sin against geometrical simplicity.

But the matter is referred to now only to show the baselessness of the claim that the metric system is a natural one, or that it is scientific becaue based on exact earth measurement common to all parts thereof.

The meter is, in fact, what it is said to be in the World Almanac:

The international standard meter is, practically, nothing else but a length defined to the distance between two lines on a platinum-iridium bar at 0° Centigrade, deposited at the international bureau of weights and measures, Paris, France.

In other words, it is nothing but a measure of length—10,000,000 of which are equal to a length 10,000,000 times as long as it is.

The meter is usually said to be 39.37 British inches. This, the unit of length, is divided into tenths, hundredths, and thousandths, called "decimeters," "centimeters," and "millimeters." It is multiplied by 10, 100, 1,000 and 10,000, called, respectively, "dekameter," "hectometer," "kilometer," and "myriameter." In surface measure a square meter is a centiare, 10 meters square is an are, and 100 meters square is a hectare. A cubic decimeter is a liter. It is divided into tenths, hundredths, and thouandths, called, respectively, "deciliter," "centi-

liter," and "milliliter;" multiplied by 10, 100, 1,000, called "dekaliter," "hectoliter," and "kiloliter or stere." The gram is said to be the weight of a cubic centimeter of pure water at its greatest density. This weight is divided into tenths, hundredths, and thousandths, called "decigram," "centigram," and "milligram," and multiplied by 10, 100, 1,000, 10,000, 100,000, and 1,000,000, named respectively "dekagram," "hectogram," "kilogram," "myriagram," "quintal," and "miller or tonneau." Here are 8 different names of length, 3 of surface, 7 of capacity, and 10 of weight—28 in all.

The essentials of the system are: (1) Uniformity. Any departure from the prescribed sizes and weights can not be tolerated. (2) Decimal division and multiplication. "Everything metric is decimal." (Rufus P. Williams in "Decadence of the Vulgar Fraction," p. 4.) (3) Nomenclature. (4) Spelling.

The report of the international committee of the Paris Universal Exposition states:

> It will be observed that the French orthography is retained throughout. This was done for uniformity and to avoid the word gram. * * * The metric system is destined to be generally international. The names and orthography of all its divisions should be equally so. For this reason alone we should refrain from Anglicizing the French names. (Davies's Metric System, p. 6.)

The system has proven inadequate. It was intended by its originators to be used for all purposes for which weights and measures are used. Its advocates now claim it to be an all-sufficient system. The experience of those countries in which it has been adopted demonstrates its inefficiency. In France, where the system originated and was first used, and where it has been tried for one hundred years, this is shown in various ways.

According to the report of the committee on coins, weights, and measures appointed by the University Convocation of the State of New York in 1872, as given in Davies Metric System, pages 19–21, the weights and measures then in actual use in France were:

Measures of length.—Double decameter, decameter, demidecameter, double meter, meter, demimeter, double decimeter, decimeter.

Measures of volume for grain.—Hectoliter, demihectoliter, double decaliter, decaliter, demidecaliter, double liter, liter, demiliter, double deciliter, deciliter, demideciliter.

Measures of volume for liquids.—Double liter, liter, demiliter, double deciliter, deciliter, demideciliter, double centiliter, centiliter.

Weights in iron.—Fifty kilograms, twenty kilograms, ten kilograms, five kilograms, double kilograms, kilograms, demikilograms, double hectogram, hectogram, demihectogram.

Weights in copper.—Twenty kilograms, ten kilograms, five kilograms, double kilograms, kilograms, demikilograms, double hectogram, hectogram, demihectogram, double decagram, decagram, demidecagram, double gram, gram, demigram, double decigram, decigram, demidecigram, double centigram, centigram, demicentigram, double milligram, milligram.

The committee says in regard to this:

> It will be seen from the above tables that the weights and measures in general use do not at all follow the decimal scale, for in all weights and all measures of volume each decimal measure has its double and its half, while the tables are constructed entirely on the decimal scale. This discrepancy between the tables and the numbers in use must give rise to much confusion, and is a striking departure from the decimal system.

From John Quincy Adams's report to Congress (given in Davies Metric System, pp. 194, 196, 197, 198) it is seen that by—

An imperial decree of February 12, 1812, the French were given: The pound=500 grams, one-half pound=250 grams, quarteron=125 grams, one-eighth or one-half quarter=62.5 grams, ounce=31.3 grams, one-half ounce=15.6 grams, one-fourth ounce, 2 gros=7.8 grams, gros=3.9 grams. So that [says Mr. Adams] the result hitherto of the most stupendous and systeamtic effort ever made by a nation to introduce uniformity in their weights and measures has been a conflict between four distinct systems.

1. That which existed before the Revolution.
2. The temporary system established by the law of August 1, 1793.
3. The definitive system established by the law of December 10, 1799.
4. The usual system, permitted by the decree of February 12, 1812. The last decree is a compromise between philosophical theory and inveterate popular habits. Retaining the principle of decimal multiplication and division for the legal system, it abandons them entirely in the weights and measures which it allows the people to use. Instead of the meter and its decimals, it gives the people a toise of 6 feet, an anne of 3½ feet, a foot of 12 thumbs, and a thumb of 12 lines. And these measures, instead of divisions exclusively decimal are divisible in halves, thirds, quarters, sixths, eighths, twelfths, and sixteenths. Instead of a decimated kilogram, it gives them a pound of 16 ounces, an ounce of 8 gros, and a gros of 72 grains.

The measures of capacity, wet and dry, have the same indulgence; and while the standard weight and measure are deposited in the national archives, the people have restored to them for use all the names and divisions of their ancient weights and measures, though not the same things. For the toise, which is twice the length of the meter, is not the old toise; the foot, which is the third part of a meter, is not the pied de roi, but both are longer measures. The half kilogram, which is a pound, is not the ancient mark-weight pound, nor are the boisseau or liter those of ancient times; they are all, respectively, near approximations to them. Without positive knowledge of the fact, the analogy of all experience warrants the conjecture that in every part of France, remote from the capital, not only the use of the old legal system, but of the local weights and measures which prevailed in the various cities and districts of the country is far from being eradicated.

Thus was its much-vaunted Greco-Latin terminology rejected in the land of its birth, and it is rejected in everyday affairs by the masses of the people in every country which is said to have discarded their old systems and adopted the new one.

Adams said (Davies's Metric System, p. 170):

The theory of this nomenclature is perfectly simple and beautiful. Twelve new words, five of which denote the things and seven the numbers, include the whole system of metrology; give distinct and significant names to every weight, measure, multiple, and subdivision of the whole system; discard the worst of all the sources of error and confusion in weights and measures, the application of the same name to different things; and keep constantly present to the mind the principle of decimal arithmetic, which combines all the weights and measures, the proportion of each weight and measure with all its multiples and divisions and the chain of uniformity which connects the profoundest researches of science with the most accomplished labors of art and the daily occupations and wants of domestic life in all classes and conditions of society.

Yet, this is the part of the system which has encountered the most insuperable obstacles in France. The French nation have refused to learn or repeat these twelve words.

They accepted a change in their weights and measures, but they rejected the decimal divisions and the peculiar terminology of the metric system, two things declared by its advocates to be essential parts of it.

When Napoleon was in exile on the island of St. Helena, realizing the disastrous confusion into which France had been plunged because of the introduction of the metric system and the legislation relating thereto, he said (memoranda for use in a history of France under

Napoleon, written at St. Helena by Gen. Comte de Montholon, Vol. IV, pp. 213–218):

The need of uniformity in weights and measures has been felt in all ages; the states general have pointed it out many times. This good gift was expected from the revolution. A sufficient simple law to assure it might have been drawn up in twenty-four hours, adopted, and put in operation in all France in less than a year. All that was needed was to make the unit of weights and measures of the city of Paris common to all the provinces.

The Government and the artists have used them for many centuries. By sending the standards into all the communes and enjoining the administrative officers and the courts from admitting any others the benefit would have been operative without effort, without restriction, and without coercive laws. Instead, geometricians and algebraists were consulted upon a question which was of administrative jurisdiction. They thought that the unit of weights and measures should be derived from a natural constant, so that it might be adopted by all nations. They thought it was not enough to provide for the advantage of 40,000,000 men; they wanted the whole universe to participate in it. They found that the meter was an aliquot part of the meridian; they made the demonstration of it and proclaimed it in an assembly composed of French, Italian, Spanish, and Dutch geometricians.

From that time a new unit of weights and measures was decreed, which did not square with the rules of the public administration, or with the tables of dimensions of all the arts, or with those of any existing machines. * * *

Meanwhile the good of present generations was sacrificed to abstractions, for to make an old nation adopt a new unit of weights and measures it is necessary to make over again all the rules of public administration, all the calculations of the arts—a task to frighten reason.

The new unit of weights and measures, whatever it may be, has an ascending and descending scale which does not accord in simple numbers with the scale of the unit of weights and measures which has been used for centuries by the Government, men of science, and artists.

No transfer can be made from one nomenclature to another, because what is expressed by the simplest numbers in the old system will have to take a composite number in the new. It will be necessary, then, to increase or diminish the amount by some fraction, so that the space or weight expressed in the new nomenclature shall be in simple numbers. Thus, for example, the ration of a soldier is expressed in the old nomenclature as 24 ounces. This is a very simple number. Translated into the new nomenclature it gives 734 grams and $\frac{259}{1000}$. It is, then, evident that it is necessary to increase or diminish the weight so as to make 734 or 735 grams.

All the component pieces or lines of architecture; all the pieces and tools used in watch making, jewelry, bookselling, and all the arts; all instruments and machines have been devised and calculated in the old nomenclature and are expressed in simple numbers, which can be translated in the new system only into numbers composed of five or six figures. It will be necessary, therefore, to do everything over again.

The scientific men also conceived another idea wholly foreign to the benefit of unity of weights and measures. They adopted the decimal numeration, taking the meter for the unit. They suppressed all complex numbers. [A complex number is a number composed of different units, as: 1 toise, 5 feet, and 9 inches.] Nothing is more contrary to the organization of the mind, the memory, and the imagination. A toise, a foot, an inch, a line, a point are fixed portions of extension, which the imagination conceives independently of their relations to one another. If, then, we ask for the third of an inch the mind goes into instant operation. The length called an inch is divided into three parts. By the new system, on the contrary, the mind has not to divide an inch into thirds, but a meter into 111 parts. The experience of all ages had made the difficulty of dividing a space or a weight by more than 12 so evident that a new name was created for each of the divisions. If the twelfth of an inch was asked for—the operation was already performed—we had the measure called the line.

The decimal numeration was applied to all the complex numbers as a unit; and if we wanted a hundredth of a point, a hundredth of a line, a hundredth was written. By the new system, if we want to express a hundredth of a line, we have to consider its relation to the meter, and this involves us in an infinite calculation.

The divisor 12 was preferred to the divisor 10, because 10 has only 2 factors, 2 and 5, while 12 has 4 factors, 2, 3, 4, and 6.

It is true that the decimal system, generalized and adapted to the meter as the unit, gives facilities to astronomers and calculators; but these advantages are far from compensating for the inconvenience of rendering thought more difficult. The prime characteristic of every method should be that of aiding the conception and the imagination, of facilitating the memory, of giving more force to the thought.

The compound numbers are as old as man, because they are in the nature of his organization, quite as it is in the nature of the decimal numeration to adapt itself to every unit, to every complex number, and not exclusively to one unit.

Finally, they used Greek roots, and that augments the difficulties; the denominations, which may be useful for men of science, were not good for the people. The system of weights and measures was one of the greatest achievements of the directory. Instead of letting time do its work, and being satisfied to encourage the new system by means of example and fashion, it made coercive laws and executed them vigorously.

The merchants and citizens were vexed by affairs indifferent in themselves, and this contributed to make unpopular an administration which put itself away from the wants and the reach of the people, violently broke with their usages, habits, and customs, as a Greek or Tartar conqueror might have done, who with uplifted rod intended to compel obedience to all his desires based upon his own prejudices and interests, regardless of those of the conquered.

The new system of weights and measures will be a subject of embarrassment and difficulties for many generations; and the first commission charged with the verification of the measure of the meridian will probably find that there are some corrections to be made. This is tormenting the people with caprices.

There is a limit to the power of the legislator, and a wise statesman will remember that; so will a shrewd politician. Adams said (Davies Metric System, pp. 89, 90, 93):

His purposes are uniformity, permanency, universality; one standard to be the same for all persons and all purposes, and to continue the same forever. These purposes, however, require powers which no legislator has hitherto been found to possess. * * * He is not infallible, he is liable to mistake the means of effecting his own objects. * * * The legislator has no power over the properties of matter. He can not give a new constitution to nature. He can not repeal her law of universal mutability. He can not square the circle. He can not reduce extension and gravity to the same measure. He can not divide or multiply the parts of the surface, the cube, or the sphere by the uniform and exclusive number 10.

The power of the legislator is limited over the will and action of his subjects. His conflict with them is desperate when he counteracts their setteld habits, their established usages, their domestic and individual economy, their ignorance, their prejudices, and their wants; all which is unavoidable in the attempt radically to change or to originate a totally new system of weights and measures. * * * In this conflict between the dominion of usage and of law, the last and greatest dangers to the principle of uniformity of which the subject is susceptible, not considering how far it should be extended, or where it finds its boundary in the nature of things and of man, enacts laws inadequate to their purpose, inconsistent with one another, sometimes stubbornly resisting, at others weakly yielding to inveterate uses or abuses; and finishes by increasing the diversities which it was his intention to abolish, and by loadng the statute book only with the impotence of authority and the uniformity of confusion.

The makers of the metric system seem to be have been decimal mad, and their failures are written large in history. They made war with nature when they undertook to decimalize time, by making a day of ten hours, an hour of one hundred minutes, a minute of one hundred seconds, a week of ten days, a month of three weeks or decades, and a year of twelve such months with five days in an ordinary year, and six days in a leap year, without names or laws applying to them and called sans cullotides (days without breeches).

They also decimalized the compass and gave it 40 thumbs instead

of 32 points. They violated both nature and grace; they were decimaniacs, and we will wisely shun their foolish example.

Shakespeare in Love's Labor Lost describes such people when he has the Princess of France to say:

> None are so surely caught, when they are catch'd
> As wit turn'd fool; folly, in wisdom hatch'd,
> Hath wisdom's warrant and the help of school,
> And wit's own grace to grace a learned fool.

And Maria to say:

> Folly in fools bears not so strong a note,
> As foolery in the wise, when wit doth dote;
> Since all the power thereof it doth apply
> To prove, by wit, worth in simplicity.

The fact given in Volume XVI of our Special Consular Reports that over 500 nonmetric units are now in use in so-called metric countries proves absolutely that the metric system for popular usage is a collossal failure. (See The Metric Fallacy, pp. 60–69.)

Now let us consider the system we have. We find it uniform, fixed, flexible, and natural, and therefore scientific, practical, and popular.

First as to its measures of length. A very close approximation to the length of the polar diameter is 500,500,000 British inches. The polar radius is therefore 250,250,000 British inches, or 250,000,000, each one being one-thousandth of an inch longer than the British inch. These inches Sir John Herschell called geometric inches, the ten-millionth part of the length of the polar radius being 25 of these geometric inches and making what is called a geometrical cubit.

In a letter to the London Times, dated April 30, 1869, Herschell said:

> As Mr. Ewarts's bill for the compulsory abolition of our whole system of weights and measures and the introduction in its place of the French metrical system comes on for its second reading on the 13 proximo, I can not help thinking that a brief statement of the comparative de facto claims of our British units and of the French on abstract scientific grounds may, by its insertion in your pages, tend to disabuse the minds of such, if any, of our legislators who may be under the impression (I believe a very common one among all classes) that our system is devoid of a natural or rational basis and as such can advance no a priori claim to maintain its ground.
>
> De facto, then, though not de jure (i. e., by no legal definition existing in the words of an act of Parliament, but yet practically verified in our parliamentary standards of length, weight, and capacity as they now exist), our British units refer themselves as well and as naturally to the length of the earth's polar axis, as do the French actually existing standards to that of a quadrant of a meridian passing through Paris, and even in some respects better, while the former basis is in itself a preferable one.
>
> To show this, I shall assume as our British unit of length the imperial foot; of weight the imperial ounce, and of capacity the imperial half pint, and shall proceed to state how they stand related to certain prototypes, which I shall call the geometrical ounce, foot, and half pint, and shall then institute a similar comparison between the French legally authenticated meter, gram, and liter in common use, with their (equally ideal, because nowhere really existing) prototypes supposed to be derived from the Paris meridian quadrant, distinguishing the former as the practical, the latter as the theoretical French units.
>
> Conceive the length of the earth's axis as divided into 500,000,000 equal parts, or geometrical inches. Then we will define (1) aa geometrical foot as 12 such geometrical inches; (2) a geometrical half pint as the exact hundredth part of a geometrical cubic foot, and (3) a geometrical ounce as the weight of one exact thousandth part of a geometric cubic foot of distilled water, the weighing

being performed as our imperial system prescribes, in air of 62° F., under a barometric pressure of 30 inches.

In like manner the theoretical kilogram and liter of the French are decimally referred to their theoretical meter on their own peculiar conventions as to the mode of weighing.

This premised (1) the imperial foot is to the geometrical in the exact proportion of 999 to 1,000 (nine hundred and ninety-nine to a thousand), a relation so numerically exact that it may be fairly considered as mathematical; and (2) and (3) the imperial half pint and ounce are, each of them, to its geometrical prototype as 2,600 to 2,601.

Turn now to the practical deviations from their theoretical ideals in the case of the French units. Here again (1) the practical meter is shorter than its theoretical ideal. The proportion is that of 6,400 to 6,401. The approximation is, indeed, closer, but the point of real importance is the extreme numerical simplicity of the relation in our case, more easily borne in mind, and more readily calculated on in any proposed case (2) and (3). Any error in the practical value of the meter entails a triple amount of aliquot error on the practical kilogran and liter, so that, in the cases of these units the proportion between their practical and theoretical values is not that of 6,400 to 6,401, but of 2,133 to 2,134. Here, then, the greater degree of approximation is in our favor; and it is to be observed that in our case this triplification of error does not hold good, since, by a happy accident, our standard pound has been fixed quite independently of our standard yard, and our gallon is defined as 10 pounds of water.

The geometrical inch equals 1.001 British inch, and the geometrical cubit equals 25.025 British inches, which is the ten-millionth part of the polar radius or polar semidiameter, together with the British yard, are all plainly marked as measures of length in the Great Pyramid of Egypt, which was built over four thousand years ago.

The primitive cubit was a fraction over 25 British inches in length. In Quiepo's Systemes Mètriques et Monetaires des Anciens Peuples, Paris, 1859, it is given as 25.19 British inches. This, however, is given only as an approximation, and many students believe it to have been identical with the cubit of the Great Pyramid, which is the device on the reverse of the great seal of the United States.

The objection of Lord Kelvin that we do not travel along the polar axis, but we do travel over the outside of the earth, and therefore a meridian is the best base, is an unworthy one, for comparatively few travel from Dunkirk to Barcelona or Formentera, and no two quadrants of a meridian seem to be of the same length, while the axis of the earth is related equally to all parts.

Our standards of length, area, capacity, and weight are as well defined as those of the metric system. They are uniform all over the country. Most of them are the same in Great Britain and her colonies. The Indian hath is 18 British inches. The Russian duim is the same length as the British inch; the verschok is 1¾ inches, the archin 28 inches; the sagine is 7 feet, and the verst is 3,500 feet.

The fingers were anciently used as a measure of length as well as to enumerate by, and it is just as natural, and therefore scientific, to measure by finger breadths, or a near approximation thereto, as it is to enumerate by tens, because we have 10 fingers to count with. The ancient finger breadth was about 0.91 of an inch in length, and the inch is so wrought into our natures and our needs in some industries that it can not be eradicated. It is a good measure of length; far superior to the centimeter, which is too small a unit for ordinary purposes. By the mechanic it is usually divided into one-half, one-fourth, one-eighth, one-sixteenth, and sometimes into one thirty-second. For other purposes it may be, and is, divided decimally as needs require.

The foot of 12 inches is a measure that is ordinarily divided into inches. Twelve is a number useful in measuring, because it divides by 2, 3, 4, and 6 without fractions. The engineer and surveyor divide the foot into tenths, because that division suits them best. Thus our foot has advantages impossible to the metric system, for "everything metric is decimal." A 2-foot rule is the handiest measure of length for the artisan that is known, and the fact that in countries where the metric system has been adopted they take three-tenths of a meter and call it a foot, and six-tenths of a meter for a 2-foot rule, and sometimes divide these measures of length into unmetric inches, shows the need for and value of these measures of length.

The ancient measures of length corresponded here, for four fingers made one palm, and three palms made one span, the span being close to 11 inches in length. The finger and span seem to have been the original prototypes of the inch and foot.

The yard of 3 feet, or 36 inches, is a better measure of length than the meter. It is an approximation to the length from the end of the middle finger to the center of the breast, or mouth, or tip of the nose, or to the length of the ordinary step or pace of the adult man. It is therefore natural in origin, being based on human measurement and human requirements, while the meter as a measure of length has no relation whatever to human proportions or needs and is a metrical monstrosity.

The yard measure is now practically confined to the measuring of textiles, and, when so used in our stores and by our tailors and dressmakers, is divided into one-half, one-fourth, one-eighth, one-sixteenth, and one thirty-second.

The mile of 1,760 yards, or 5,280 feet, or 63,360 inches, is of no peculiar merit or value that I know of; but it is superior to the kilometer for the giving of long distances; for, as the kilometer is less than two-thirds of a mile, it takes less figures to give distances in miles than in kilometers.

Railroad distances are given in miles and tenths of miles. A kilometer is 39,370 inches. Two-thirds of a mile is 42,240 inches. The kilometer is therefore 2,870 inches, or one twenty-second part of a mile less than two-thirds of a mile. With us railroad fare is 3 cents per mile; if the railroads charged 2 cents per kilometer, they would gain about a cent on ever 7 miles. Travelers of course would pay that much more. That might be good for millionaire railroad owners, but it would be hard on the general public.

Our land is divided into sections 1 mile square. Each section contains 640 acres; these into one-fourth sections containing 160 acres; this, divided by 4, gives 40 acres, and that divided again by 4 gives 10 acres.

I do not know that the acre has anything scientific about it, but it is fixed in our land surveys. Surveyors now estimate in acres and hundredths of an acre, as they measure in feet and tenths of a foot. It therefore should be left alone. In land measure, yards, poles, rods, roods, links, and chains, are practically obsolete and can not be reckoned against our system.

The bushel is divided into 4 pecks, the peck into 2 gallons, the gallon into 4 quarts, the quart into 2 pints, and the pint into 4 gills.

Probably the difference in dry and fluid measures might be improved by being made uniform, but the method of division should be retained.

The people's pound—the avoirdupois pound—the pound most used, is divided into 16 ounces, and custom gives one-half, one-fourth, one-eighth, and one-sixteenth, 16 drams being 1 ounce.

The mariner's compass is divided into 32 points and the circle into 360 degrees. The nearest attempt to harmonize these with the metric system made by its originators—the division of the compass into 40 rhumbs and the circle into 400 degrees—proved as farcical a failure as the decimalization of time. Consistency demanded that the compass be divided into 100 degrees and the circle into 1,000 degrees, but that was seen to be practically impossible, so the first division in compass and circle was by 4 in order to harmonize with nature.

Musical time is divided thus: Whole note, one-half note, one-fourth note, one-eighth note, one-sixteenth note, one thirty-second note, one sixty-fourth note. An attempt to produce music by decimal notation would result in frightful effects and prove as futile as an attempt to make the earth revolve on its own axis 400 times while revolving around the sun once, so that the 40-rhumb compass and the 400-degree circle might displace those now in universal use.

These things are not so simply because our ancestors made them so or because they were ignorant, but because it is as natural for the human mind to divide by what are caller vulgar or common fractions as it is to enumerate by tens.

Our money is decimal, and yet the textile worker and draper's yardstick is not divided decimally. In stock exchange quotations the fractions of a dollar are given as one-eighth, one-fourth, three-eighths, one-half, five-eighths, three-fourths, seven-eighths. We are told that when entered on the books these fractions are set down as 0.125, 0.25, 0.375, 0.50, 0.625, 0.75, 0.875, but why this mongrel system of representing common fractions by decimals? Why not use decimal division and write 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9? Just because it is unnatural. The human mind does not work that way easily.

Speaking on this point in his report to Congress on the metric system, Mr. Adams (Davies's Metric System, pp. 198, 199, 200) said:

> Its authors do not appear to have considered, in all the bearings of the system, the proportions dictated by nature between the physical organization of man and the unit of his weights and measures. The standard taken from the admeasurement of the earth had no reference to the admeasurement and powers of the human body. The meter is a rod of 40 inches (nearly), and by applying to it exclusively the principle of decimal divisions, no measure corresponding to the ancient foot was provided. A unit of that denomination, though of slightly varied differences of length, was in universal use among all civilized nations; and the want of it is founded in the human body. Perhaps for half the occasions which arise in the life of every individual for the use of a linear measure, the instrument, to suit his purposes, must be portable, and fit to be carried in his pocket.
>
> Neither the meter nor the half meter are suited to that purpose. The half-meter corresponds indeed to the ancient cubit; but perhaps one of the causes which everywhere, since the time of the Greeks, substituted the foot in the place of the cubit, has been the superior convenience of the shorter measure. Besides which, the cubit being the unit, the half-cubit might serve the purposes of the foot; but the meter, divisible by only two and by ten, gave no measure practi-

cally corresponding with the foot whatever. It appears also not to have been considered that decimal arithmetic, although affording great facilities for the computation of numbers, is not equally well suited for the divisions of material substances. A glance of the eye is sufficient to divide material substances into successive halves, fourths, eighths, and sixteenths. A slight attention will give thirds, sixths, and twelfths. But divisions of fifth and tenth parts are among the most difficult that can be performed without the aid of calculation. Among all its conveniences, the decimal division has the great disadvantage of being itself divisible only by the numbers two and five.

The duodecimal division, divisible by two, three, four, and six, would offer so many advantages over it that while the French theory was in contemplation the question was discussed whether the reformation of weights and measures should not be extended to the system of arithmetic itself, and whether the number twelve should not be substituted for the number ten, as the term of periodical return to the unit. Since the establishment of the French system this idea has been reproduced by philosophical critics as an objection against it; and Delambre, in the third volume of the Base du Systeme Metrique, page 302, has considered it, and assigned the reasons for which it had been rejected. He admits to the full extent the advantages of a duodecimal over a decimal arithmetic; but alleges the difficulty of effecting the reformation as the decisive reason against attempting it. The metrology of France is a new and complicated machine, formed upon principles of mathematical precision, the adaptation of which to the uses for which it was devised is yet problematical, and abiding with questionable success the test of experiment.

I have quoted somewhat extensively from John Quincy Adams's report, because he is too often falsely represented by the advocates of the metric system as being in favor of it, which he certainly was not; from Napoleon, because he was a statesman, whose fine statesmanship was made to appear less by his wonderful military genius; and from Sir John Herschell, because his fame as an astronomer, mathematician, and scientist was world-wide; and because the opponents of the French metric system and defenders of our own are too often stigmatized as ignorant and unscientific.

Compare the short, sharp Saxon words found in the vocabulary of our weights and measures—inch, foot, yard, mile, acre, ounce, pound, ton, pint, quart, gallon, peck, bushel—with the long, many syllabled, similar sounding Græco-Latin-Gallic names of the metric system and it is no wonder the people will not give up the one for the other. The attempt to compel them to do so by drastic legislation and arbitrary fines and punishment finds its parallel in Mrs. Partington's attempt to sweep out the Atlantic with a mop.

It is one of the boasts of the advocates of the metric system that its terminology is scientific, and that its sounds convey clear ideas to the mind, while that of the Anglo-Saxon system does not.

But that is most scientific which is most in harmony with nature; in language, that which conveys to the mind a definite idea not likely to be confounded with another in the shortest possible word most unlike any other. This is seen to perfection in the Anglo-Saxon system. The words used are so unlike each other that there is no possible chance of mistaking any one for another, or confounding words used for measures of length, area, capacity, and weight.

Here the terminology of the metric system fails, and even the trained mind will often use words to denote length, capacity, and weight that belong to another table. The mental effort required to speak or write is greatest in the metric system. Nature demands economy—the greatest result from the least effort.

That the adoption of the metric system will increase our trade is absurd. These figures show the wonderful strides we are making.

Who really believes that France or Germany are anxious for us to adopt the metric system if they think it would increase our competition with them and make us more successful?

House builders and house owners do not want the metric system. Houses already built are made to British measures, and when these measures are converted into metric measures they are fearful to look at and read. Window glass is now made and sold in standard sizes of specified inches. If it was in standard metric sizes larger panes must be bought to replace old ones, necessitating cutting, and greater expense; and so with doors, slates, and everything else. To illustrate this, at the request of a member of this committee I here give some conversions in illustration. The house is from Keith's Magazine on home building, February, 1904, design No. 581.

A lot 200 feet by 75 feet would be 60.96 by 22.86 (60 meters 9 decimeters 6 centimeters by 22 meters 8 decimeters 6 centimeters).

Outside dimensions of house, 41 by 37 feet; in metric measure, 12.4968 by 11.2776 (12 meters 4 decimeters 9 centimeters 6 millimeters plus by 11 meters 2 decimeters 7 centimeters 7 millimeters plus).

The method of conversion is: One foot equals 0.3048 meter, therefore multiply 0.3048 by 41 and 37:

0.3048	0.3048
41	37
3048	2.1336
12.192	9.144
12.4968	11.2776

The dining room is 13 feet by 21 feet 6 inches. To find floor space:

13.0
21.6
6.6
13
26
279.6

279 feet 6 inches.

To convert into metric measures:

0.3048
13
.9144
3.048
3.9624

3 meters 9 decimeters 6 centimeters 2 millimeters plus.

0.3048
21½
1524
3048
6.096
6.5532

6 meters 5 decimeters 5 centimeters 3 millimeters plus.

To find floor space in metric measures:

3.9624
6.5532
7.9248
118.872
1,981.20
19,812.0
237,744
259,663.9968

25 square meters 96 square decimeters 63 square centimeters 99 square millimeters plus.

On page 207 of these hearings is given the names of 198 members of the British Parliament said to "have notified their approval of the compulsory adoption of the metric weights and measures."

At the bottom of the page is this:

Total, including a number added, 259.

Then on page 208 is:

In addition to the above, 30 members of Parliament have signified their approval, but withhold authority to publish their names.
Since January 30, 31 members of Parliament have signified their approval.

Now, all this is very mysterious and misleading. No authority is quoted for these figures and no one stands sponsor for them. Why add 61 to the number of names given without giving the names?

The statement that "30 members of Parliament have signified their approval, but withhold authority to publish their names," leaves the number indefinite. For no one can tell if the latter 30 form part of the unnamed 61, of whom nothing is said as to the publication of their names. If the 61 were willing to have their names published, why was that not done? If only 30 objected, why was not the 31 published? Seemingly the impression intended to be created is that 320 favor the measure. But, if that is a fact, that number is not a majority, for there are 670 members of Parliament; so that, even according to this showing, there are 350 avowedly opposed to the measure, and many others are noncommittal. This means not the adoption but the rejection of the measure, and the fact is the British people do not want the system any more than the people of the United States do, and any attempt to foist it upon them will meet

with the ignominious defeat it deserves. One stock reason the metric advocates in England have why the British Parliament should make the system compulsory is that the United States will get ahead of the English, make it compulsory, and reap its benefits first.

In the United States metric people want it made compulsory here, and then, they say, England and her colonies must adopt it; but if this system is as good as its advocates claim, and as much better than the one they seek to overthrow as they declare it to be, it will win on its merits without further legislation. The fittest will survive. For our people to throw away our present system and adopt a mongrel system, taking three-tenths of a meter for a foot and dividing it into inches instead of centimeters, etc.; a liter for a quart, and dividing it into pints and gills and taking multiples of it for gallons, etc., and half a kilogram for a pound and dividing it into ounces, etc., as the French did, would be absurd, as that would be still another system, neither metric nor anything useful, and would only make confusion where we now have uniformity.

If Congress will give the people a coin of the value of one-half cent, it will supply a long-felt and ever-present need and they will rise up and bless you.

I do not know whether any of you gentlemen would like to know what that diagram is. This [indicating] is a cube of a geometrical foot, and one-thousandth part of that cube filled with pure water weighs an ounce; and ten of them, or the one-hundredth part of the 12-inch cube is a half-pint. That is the approximate base of the British system, as described in this statement.

Mr. BROWN. Could not that be put in the report?

Mr. WARRENER. I think it might be reduced, if the committee sees fit, and go into the report. It illustrates part of my remarks. It is an original diagram that I drew myself just before I started from home.

TESTIMONY OF WILLIAM SELLERS.

Mr. SELLERS. The adoption of the French metric system for this country has been urged frequently—never, perhaps, more earnestly than in the early part of the last century. At that time every branch of the mechanic arts was in its infancy; the planing machine itself was unknown in this country; the hammer, the cold chisel, and the file were our only means for producing a plane surface in metals. At such a time, if ever, it might be supposed the metric system would find favor in this country, and on the 14th of December, 1819, the House of Representatives passed the following resolution, viz:

Resolved, That the Secretary of State be, and he is hereby, directed to report to this House a statement relative to the regulations and standards for weights and measures in the several States, and relative to proceedings in foreign countries, for establishing uniformity in weights and measures, together with such a plan for fixing the standard of weights and measures for the United States as he might deem most proper for their adoption.

In obedience to this resolution, on the 22d of February, 1821, John Quincy Adams, then Secretary of State, made a very full and able report. I will not attempt to follow the reasoning of the author, but only to quote his conclusions so far as concerned the metric system:

In the review which has been taken and the comparison which has been submitted to Congress between the old English and the new French, or as they

may with more propriety be called, the ancient and the modern systems of metrology, it has been the endeavor of this report to show that, while each of these systems embraces principles of the highest importance, neither of them includes all the elements resulting from the nature of the relations between man and things as created beings, and between man and man in society, mingling in the purposes to which weights and measures are applicable. The opinion has been expressed that the uniformity of proportion in the ancient system, uniting weight and measure by the relative gravity, extension, and numbers incident to dry and liquid substances, possessed advantages of which the uniformity of identity in the modern system was entirely deprived; that the property of the ancient system, by which the money weight and the silver coin were the same, the most useful of all uniformities of which weights, measures, money, and coins are susceptible, was very imperfectly adapted to the modern system of France: that the French system, admirable as it is, looked, in its composition, to weights and measures more as exclusively matters of account than as tests of quantity; that in its eagerness for extreme accuracy in the relations between things it lost sight a little of the relations of weights and measures with the physical organization, the wants, comforts, and occupations of man; that in its exclusive partialities for decimal arithmetic it forgot the inflexible independence and the innumerable varieties of the forms of nature, and that she would not submit to be trammeled for the convenience of the countinghouse.

The experience of the French nation under the new system has already proved that neither the immutable standard from the circumference of the globe, nor the isochronous vibration of the pendulum, nor the gravity of distilled water at its maximum of density, nor the decimation of weights, measures, moneys, and coins, nor the unity of weight and measure of capacity, nor yet all these together, are the only ingredients of practical uniformity for a system of weights and measures. It is proved that gravity and extension will not walk together with the same staff; that neither the square nor the cube nor the circle nor the sphere nor the revolutions of the earth nor the harmonies of the heavens will, to gratify the pleasure or to indulge the indolence of man, be restricted to computation by decimal numbers alone.

The substitution of an entire new system of weights and measures, instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is indeed no difficulty in enacting and promulgating the law, but the difficulties of carrying it into execution are always great, and have often proved insuperable. Weights and measures may be ranked among the necessaries of life to every individual of human society. They enter into the economical arrangements and daily concerns of every family. They are necessary to every occupation of human industry, to the distribution and security of every species of property, to every transaction of trade and commerce, to the labors of the husbandman, to the ingenuity of the artificer, to the studies of the philosopher, to the researches of the antiquarian, to the navigation of the mariner and the marches of the soldier, to all the exchanges of peace and all the operations of war. The knowledge of them, as in established use, is among the first elements of education, and is often learned by those who learn nothing else, not even to read and write.

This knowledge is riveted in the memory by the habitual application of it to the employments of men throughout life. Every individual, or at least every family, has the weights and measures used in the vicinity and recognized by the custom of the place. To change all this at once is to effect the well-being of every man, woman, and child in the community. It enters every house, it cripples every hand. No legislator can attempt it with any prospect of success or any regard to justice but upon two indispensable conditions: One, that he shall furnish every individual citizen easy access to the new standards which take the place of the old ones, and the other, that he shall enable him to know the exact proportion between the old and the new. A multiplication of standard copies to a great extent is indispensable, and the distribution of them throughout the country, so that they may be within the means of acquisition to every citizen, is among the duties of the Government undertaking so great a change. Tables of equalization must be circulated in such manner as to find their way into every house, and a revolution must be effected in the use of books for elementary education and in all the schools where the first principles of arithmetic may be taught. All this has been done in France, and all this might be done, perhaps, with more ease in the United States. But were

the authority of Congress unquestionably to set aside the whole existing system of metrology and induce a new one, it is believed that the French system has not yet attained that perfection which would justify so extraordinary an effort of legislative power at this time.

The doubts entertained whether an authority so extensive as this operation would require has been delegated to Congress are strengthened by the consideration of the character of the Executive power, corresponding with the legislative authority. The means of execution for enacting and obtaining the conformity of individuals to the ordinances of the law, in the case of weights and measures, belong to that class of powers which, in our complicated political organizations, are reserved to the separate States. The jurisdictions to which resort must be had for transgressions of this description of laws are those of municipal police. In England they were originally of the resort of views of frankpledge in every separate manor, and have since been transferred to the clerks of the market and to the justices of the peace.

The sealers of weights and measures, officers who have the custody of the standards and the authority to compare with them, from time to time, the weights and measures used by individuals, and to prosecute for all offenses by variations from the standards, and the courts before whom all such offenses are triable are institutions not only existing in almost every State in the Union, but essentially belonging to that portion of public authority suited to the State administration rather than to that of the Union. It is a general principle of our constitutions that, with every delegation of legislative authority, a coextensive power of execution has been granted. Affairs of municipal and domestic concern have, for obvious reasons, been reserved to the State authorities; and of this character are most of the regulations and penal sanctions for securing conformity to the standards of weights and measures.

In fixing the standard it is believed the Congress must rely almost entirely, if not altogether, upon State executive authorities for carrying their law into execution. And, although this reliance may be safely indulged in relation to a law which should merely fix the uniformity of existing standards, its efficacy would be very questionable in the case of a law of great and universal innovation upon the habits and usages of the people. Of such a law the transgressions could not fail to be numerous; any doubt of the authority of the legislator would stimulate to systematic resistance against it; and the power of enforcing its execution being in other hands, naturally disposed to sympathize with the offender, the whole system would fall into ruin and afford a new demonstration of the impotence of human legislation against the laws of nature in the habits of man.

At the time when John Quincy Adams was preparing this report Eli Whitney, at the arsenal at Harpers Ferry, in Virginia, was developing a process of manufacture, that of making the parts of like machines interchangeable, which has since revolutionized mechanical construction. The idea was not original with him, for it was attempted in France in the latter part of the preceding century at several Government shops, but in 1807 the last factory was dismantled because it had not only failed to produce interchangable parts, but what it did produce was at an increase of cost. Whitney recognized two conditions: One, that commercially you could not make two things exactly alike; the other, that all of the work must be performed by machines. To meet the first he devised what he called "tolerance gauges," one of which was larger than the desired product, the other smaller, and these two determined the allowable variations.

The small arms of our Government were thereafter manufactured upon this system, and it subsequently extended to a great variety of productions, so that for at least half a century this country was possessed of a process of manufacture unknown to the rest of the world, a system not only much cheaper in productive capacity, but the product was superior in quality. This system required for each article at

least two gauges, and to-day the factories engaged in such production are to be found all over our land. The tolerance gauges required by such a system, expensive as they are, represent but a small proportion of the expenditure required, the special drills and boring bars, with the apparatus necessary for guiding them to the exact location of the holes, the templates for holding the work for successive operations, referring as they must to one surface, reamers, mandrels, etc., in the aggregate amount to an enormous sum. For example, a complete set of such special tools and appliances for the manufacture of a new machine cost my company upward of $90,000 before the first machine was completed. All of these tools and appliances, as well as all the machinery of our plant, are based upon the inch measure, and all of the special tools for any lot of work must be discarded if the French metrical system is adopted as the legal system of measurement, and others similar, but to accord with the new metrology, must be substituted for any new lot of machines of the same design that may be built thereafter.

The machines that are made under the old metrology would exist and be practically workable perhaps as long as any man would live. To keep them in repair you would have to be able to make the parts over again the same as they had been made originally, and that would keep up two systems. The manufacturer knows what that is. I suppose you gentlemen have not a conception of it. You can not do business that way. You can not manufacture in that way. You have got to do things alike.

Mr. SHAFROTH. Are not some of the manufacturers manufacturing machines according to the metric system on account of the demand for that kind of thing?

Mr. SELLERS. Doubtless. It is just as easy to use one system as another, but you have the preparation for one system, and you throw it all away. When you do that you exchange these tools for others exactly like them that will not enable you to do a bit more work. You exchange the one system for the other.

Mr. SHAFROTH. But have not some manufacturers found it to their advantage commercially, notwithstanding they are manufacturing implements according to the foot measurement or the English measurement, to also have a system of tools for the manufacture of things according to the metric system?

Mr. SELLERS. I think that is quite possible, but they do that of their own motion. They are not compelled to do it. They are not compelled to throw all their tools and appliances away and put in something else that is exactly like them.

Mr. BROWN. What class of manufacturers would that be?

Mr. SELLERS. I do not know.

Mr. BROWN. Do you know, Mr. Shafroth?

Mr. SHAFROTH. We had one or two here last year.

Mr. BROWN. I think Mr. Sellers himself manufactures to a certain extent in the metric system.

Mr. SELLERS. Certainly.

Mr. LANNING. I understand your present point to be that in any work that has been constructed according to the metric system of metrology it would be impossible to use a table of equivalents and thereafter to do work by way of repairs upon machinery so constructed under the metric system.

Mr. SHAFROTH. There is no doubt of that.

Mr. SELLERS. That is true, because we do not work by tables. We have to make our gauges.

Mr. LANNING. I understand that to be your reason for saying that the tools that have been in use would have to be disposed of if you adopt the metric system?

Mr. SHAFROTH. That is, if the law were compulsory; if it required them to do it.

Mr. SELLERS. Compulsory or otherwise. We will suppose a machine has been made and great numbers of them are in use. The new system would require changes. You could not tell the difference to look at the two machines when they are standing side by side; but you could not repair the old machines unless you had the tools with which it was to be done.

Mr. LANNING. That is exactly what I mean.

Mr. SELLERS. You would have, therefore, to retain a set of tools for the old system. Still you would build others exactly like them and no man could tell the difference between them from looking at them. By measurement you would be able to tell the difference. You would have no more capacity to do work, but you would have made an investment which, as you see, would be enormous. I have referred to one machine built in our place, or which we are now building, and I wrote from memory what we expended upon it and then, fearful that I might have stated it too high, I referred to the accounts, and found that, instead of being $90,000, it was very nearly $100,000—$99,000 and some odd dollars—that we had spent for these special tools and appliances for making work interchangeable.

The CHAIRMAN. Of course there would be nothing requiring you to change these machines until public demand required a change, and until that occurred you would simply use the same tools in reproduction of the same machines.

Mr. SELLERS. Well, that is another question. I do not quite agree with you as to that. I think we should be really compelled to change.

The CHAIRMAN. Why?

Mr. BROWN. If the Government adopted the system, Mr. Sellers, would you not be obliged to have a set of tools to conform to it?

Mr. SELLERS. Certainly.

The CHAIRMAN. Why?

Mr. SELLERS. Suppose the Government was obliged to have its machinery made in accordance with the metric system. They get it made. If we want to build any of it, we would have to make it in accordance with the metric system. We would have to make the tools and gauges to do it with. We have already tools and gauges that would make just as good a machine.

The CHAIRMAN. That is presupposing another case. Supposing you were to provide the Government with a tool or machine that you did manufacture. There would be no necessity for the use of metric measures or weights in the construction of that machine by the manufacturer himself, would there?

Mr. SELLERS. Well, I can conceive that the Government could not possibly order a machine unless it was made in accordance with the metric system, because they are obliged, when they take the machine, to weigh and measure the thing in accordance with that system.

Mr. SHAFROTH. Is not that only in the manufacture of special things? They would not order an engine by the metric system, and they do not order it by the inch or foot system. They order it by the horsepower, do they not?

Mr. SELLERS. No; they have to have something a little more definite than that.

Mr. SHAFROTH. However, they do not go into the intricate parts of a machine when they order an engine, do they?

Mr. SELLERS. I hold that if this bill becomes a law the officers of the Government would inspect a machine in accordance with the law, and if they find that its dimensions do not conform to the metric system they can not but condemn it.

Mr. LANNING. Are you now sometimes furnished with specifications by the Government which give you measurements in feet or inches; or are you not?

Mr. SELLERS. I do not recall that we are. It is not usual.

Mr. LANNING. Some of the Departments do.

Mr. SELLERS. For some special things, undoubtedly, that might be, but as a rule the Government does not want to make itself responsible for anything.

The CHAIRMAN. As a matter of fact, Mr. Sellers, there is little trouble in stating any dimension given in one system in the equivalent of the other.

Mr. SELLERS. If you want to call an inch gauge 25.4 millimeters, you can do it. We have always been able to do it, but to do that continuously when you mean an inch, to say 25.4 millimeters, would be inconvenient. It would not amount to anything, but it would be very inconvenient. There would be no good in it, either.

The CHAIRMAN. You say the Government does not generally do that, but if it did do it, and you were required to construct a machine involving that kind of a requirement on the part of the Government, you could easily use the metric equivalent?

Mr. SELLERS. I want the metrical people to tell me what they are going to accomplish, how we are going to be benefited by adopting that system.

The CHAIRMAN. Of course we recognize that the manufacturing industry is a very important industry; but, of course, when we consider a matter such as the proposition to adopt a system of weights and measures to replace one that we have, we must consider the whole field to be occupied by the weights and measures.

Mr. SELLERS. I am perfectly willing you should do that, but I want you to tell the whole people how they are going to be benefited by going to this enormous expenditure to adopt a new system of metrology—let them know thoroughly.

Mr. CANDLER. Do you know any special benefits that would be derived from the adoption of the metric system to the people throughout the country?

Mr. SELLERS. No, I do not. I recognize special disadvantages that would result in the adoption of the metric system. I shall touch upon that later.

Mr. CANDLER. What is the character of your business that you speak of, in which you refer to those tools? What kind of tools are they, and what line of business are they used in?

Mr. SELLERS. The kind of tools I refer to as having cost upward

of $90,000 would be for any kind of machine manufactured. There would be the gauges and tools and appliances necessary to make the work interchangeable. It is quite a different thing to build a machine any way that you see fit without any reference to any other machine, but you undertake to build machines that will be interchangeable, then you have an entirely different problem to solve.

Mr. CANDLER. And the adoption of this system, making it compulsory on the Government, would affect the business of the people throughout the country by reason of the fact that the influence to be brought about by the Government being required to use these weights and measures would apply to them indirectly, if not directly, all the time?

Mr. SELLERS. Yes.

The CHAIRMAN. What kind of tools were they, Mr. Sellers? What were the tools you had to purchase that cost $90,000?

Mr. SELLERS. We did not have to purchase them. We had to make them.

The CHAIRMAN. I mean what tools were they, whether you purchased them or made them?

Mr. SELLERS. Well, they are enormous in number.

The CHAIRMAN. What was the character of them?

Mr. SELLERS. I state in this paper that when Whitney undertook to make machinery the parts of which should be interchangeable, he recognized that you could not commercially make two things exactly alike, and therefore it was incumbent upon him to say how much smaller he might go, or how much larger he might go than the exact standard, and that could not be very much.

The CHAIRMAN. I have reference to these tools which you made.

Mr. SELLERS. I am telling you, sir.

The CHAIRMAN. I beg your pardon.

Mr. SELLERS. He had to make those gauges for determining the sizes. Now, that was a thing that theretofore had never been done. Those tools we had to make. Every article that was made, every little piece of the machinery, had to have two of those gauges in order to determine. That shows what an enormous amount of them there were.

The CHAIRMAN. How many gauges?

Mr. SELLERS. I could not possibly tell you. I only tell you that the accounts show that they cost within a few dollars of $100,000.

The CHAIRMAN. Anything besides gauges?

Mr. SELLERS. Oh, yes; all the special tools and appliances that had to be used to produce the pieces of these machines had to have tools and gauges for producing them.

Mr. BROWN. Did you tell the committee the nature of your business and what you make?

Mr. SELLERS. We make machinists' tools. That is our principal business, the making of machinists' tools.

Mr. BROWN. Well, I know; but the committee does not. Are you making hammers?

Mr. SELLERS. Yes; steam hammers, almost all machinists' tools. The fact is, we were the first house in the country to make machinists' tools, so we got to making a great many more than we ought to have made.

Mr. BROWN. There is a great variety of them?

Mr. SELLERS. A great variety of them, and we have too great a variety. We have tried to cut that down. We have got to making less and less.

Mr. CANDLER. The change in this system then would require these tools to be changed, not only in your business, but by reason of the fact that you manufacture these tools to be used throughout the country, it would affect the people throughout the United States and require them to have different kinds of tools.

Mr. SELLERS. No; if there are repairs, they would have to come back to us. In fact, that is what that system means, that it is cheaper to make a new thing than it is to repair an old one.

Mr. CANDLER. Mr. Shafroth asked you about the Government buying an engine by the horsepower. Do they not always buy it by the length of the shaft and the different constructions that enter into the engine?

Mr. SELLERS. In every way; whatever is indispensable with them.

Mr. CANDLER. The flues in the boiler that goes with the engine are governed by certain measurements, length, and diameter, and all that sort of thing. These different things enter into the horsepower of the engine and the horsepower of the boiler, do they not?

Mr. SELLERS. What enters into the horsepower of the engine is the diameter of the cylinder and the length of the stroke.

Mr. SHAFROTH. But the Government orders standard engines when it orders. It does not take a special engine made according to its line of measurements?

Mr. SELLERS. Sometimes.

Mr. SHAFROTH. Unless it is for a special purpose.

Mr. SELLERS. Yes.

Mr. BROWN. Is not the size of the engine and the cylinder always specified?

Mr. SELLERS. I think so. I think the Government always specifies that. Still there are cases I can easily imagine when it would not be necessary.

Mr. SHAFROTH. Do you not regard, Mr. Sellers, that it is a step in the right direction to have a uniform system of measurements with the balance of the world?

Mr. SELLERS. We have a more nearly uniform system of measurement now than they have in any metrical country.

Mr. SHAFROTH. Do you expect, or do you hope, that the countries that now have the metric system will ever come to our system?

Mr. SELLERS. I think that it is much more likely that they will do that than that we shall come to their system.

Mr. SHAFROTH. Did you ever hear of any agitation in a country that had adopted the metric system to adopt the English system of weights and measures?

Mr. SELLERS. Not the English system; but after years of the metric system, the rebellion was so great against it that in Napoleon's time they passed an act that allowed the people to go back to the old measurements.

The CHAIRMAN. Come down to the last fifty years, since it has been reasonably well established. Have you ever heard of any agitation on the part of any metric country to go to any other system?

Mr. SELLERS. No; I have not.

Mr. CANDLER. Is there any country in which the metric system is universally used, although it has been adopted in several countries?

Mr. SELLERS. There is no country in the world where it is universally used. I say without fear of contradiction that our system, imperfect as it may be, is much more universal in all English-speaking countries than the metric system is in any metrical country.

Mr. CANDLER. Is not our system the system which is used almost universally in all countries of English-speaking people throughout the world?

Mr. SELLERS. Entirely so.

Mr. CANDLER. Has the metric system ever been adopted by any people of their voluntary will and desire?

Mr. SELLERS. Not by any means; but in our own country there are numerous branches of business to which the metric system is well adapted. The electricians use it. The chemists use it largely, and they think it is just the thing, and so it is. It suits them perfectly; but you will not find mechanics who will use it.

Mr. SHAFROTH. You mean American chemists use the metric system?

Mr. SELLERS. Oh, yes.

The CHAIRMAN. Every importer must use it, Mr. Sellers?

Mr. SELLERS. Well, it is of small consequence, Mr. Chairman. I am just going to give you an instance here of what we do in this country. I venture to say that the whole of our foreign trade in machinery, all the profit we could make out of it, would not pay a percentage of the cost.

Mr. LANNING. You mean the cost involved in the change?

Mr. SELLERS. Yes. The screw bolts and nuts which enter into the construction of every machine, and which unite the rails on more than 100,000 miles of roads in this country, are interchangeable, so that a nut made in Maine will screw upon a bolt made in Texas of like normal size.

The shops of our railroads have frequent demands to repair the loss of one or the other of these parts from the cars of through trains which may traverse the whole extent of our country. This is now done without loss of time and with the minimum of cost. Without this system the loss of time for a train lacking a bolt would exceed hundreds of times the cost of the new bolt. The metrical countries now generally use the English system of screw threads, but they are introducing metric screws, so that they will be, if they are not now, in the condition we were fifty years ago when every shop made its screws to suit its own convenience. Generally the pitch accorded nearly with that of the English practice, but the angle of the thread and its shape had no semblance of it, so that interchangeability was not thought of. We have now a well-established system, not only for the form of every detail of these indispensable articles, but also for their manufacture, so that the parts will be interchangeable. We have attained to a system superior to any other the world affords, and we are now threatened with a law, which, if adopted, will make it necessary to abandon all that we have accomplished, and to what end? Not that there is any other system better than ours, but solely that we may conform to another system of metrology which does not

lend itself to such constructions, so that even metrical countries have only succeeded in introducing confusion after a century of effort to displace our system based upon the inch.

The friends of the metrical system will undoubtedly say changes of this character will not be required, but it is only three years since a convocation of scientists, representing the metrical countries of Europe, met finally at Zurich, in Switzerland, and adopted a system of bolts and nuts conforming to the French metrical system.

Throughout Europe they have, and have had for years, the English system. They are bound to keep that up because there are lots of things that those bolts or nuts have to be replaced for. They have to keep up the old system and they have to make a new one, and there must necessarily be confusion. Forty or fifty years will not see them out of it.

Mr. SHAFROTH. The manufacturers did that themselves, did they not?

Mr. SELLERS. What?

Mr. SHAFROTH. Passed this resolution indorsing the change to the metric system.

Mr. SELLERS. The manufacturers, as a rule, do not talk much. They manufacture; but the scientific people, who are purely scientific, think they know what the manufacturer needs a great deal better than he does himself. It is an academic system without being a practical system.

Mr. SHAFROTH. This agreement that was made was made by whom?

Mr. SELLERS. At Zurich?

Mr. SHAFROTH. Yes, sir.

Mr. SELLERS. It was a convocation of people there—I dare say of metrical people—who desired to introduce the metric system for bolts and nuts. Understand me, it will not make a better nut or a better bolt, and it will not make a worse one. It will be just as good when it is done, but what on earth is the use of changing when you gain nothing by it?

The CHAIRMAN. Who did this, the manufacturers?

Mr. SELLERS. I do not think it was the manufacturers.

Mr. SHAFROTH. Nobody could compel the manufacturers to do it. There is no international law on the subject. There can not be.

Mr. SELLERS. It is not that; but patriotism will be appealed to, all sorts of appeals will be made, and lots of people in order to have the coming system in this country want to have the metric system because they believe it is the coming system. I believe our system will outlast it, far and away. It would be a great public misfortune if the metric system was to be adopted in this country any more than it is.

Mr. HEDGE. Where do they get repairs in Europe on our American machinery?

Mr. SELLERS. They make them themselves.

Mr. HEDGE. They make them on the American system, do they not?

Mr. SELLERS. Oh, no; an interchangeable system is the system that will make the best work and the cheapest work, but there is a comparatively small amount of machinery that is made that way. It is necessary that there should be a great number of parts alike, of one kind. You can not afford to do it at all if your product is something

that you only make a few of each year. You have to have something to keep you going all the time.

Mr. HEDGE. You did not understand me. I refer to an American machine shipped to Europe and sold there that needs repair. How do they get the repairs?

Mr. SELLERS. Suppose it is a bolt that is broken. They can make another bolt and cut the thread on it to suit the nut, or they can make a bolt and nut both and put it in.

Mr. HEDGE. They have to make the same bolt and nut that was there originally, do they not?

Mr. SELLERS. No; not necessarily. It may be nothing like the original except for size. It has to fit the hole that the other one went into, but the thread may not be alike, either in form of thread or pitch; but the thread on the bolt and in the nut that is going to be used have got to be alike.

Mr. LANNING. Suppose a shaft is broken that is 3 feet 6½ inches long. Will they supply that by giving a measurement 3 feet 6½ inches, or will they give its equivalent in metric measurement?

Mr. SELLERS. The probabilities are they would give its metrical dimensions; but if the shaft has bearings to fit, they would have to furnish a gauge, and they can turn that to anything, you know.

The proposition to change our system for the sole object of conformity with a system which in this particular has not even been accepted in metric countries, is absurd, and could only emanate from men utterly ignorant of the conditions required, and of the necessary apparatus to fulfill them.

The confusion and loss upon our railroads alone, resulting from a change of this one item, would be incalculable during the long period that would be required to accomplish it. But such a change could not be even commenced until other changes preliminary thereto had been first effected. Look through any well-equipped tool room. Note the great variety of drills, boring bars, and cutters, taps, dies, reamers, and gauges that are made to standard sizes. All of these must be first changed; but before such change could be commenced, the standards of sizes must be decided upon and prepared. The productive energy of the country would be set back half a century before this could be effected, and when it was accomplished we would not have from the change any new appliance for increasing our productive capacity; we would only have changed our standard of an inch for that of the millimeter.

I want you gentlemen to understand that you do not give us anything that will enable us to produce any more or any better. You merely ask us to change our sizes to another system of metrology. I say it would cost us fifty years of labor to do it, and an incalculable amount of money. All the money you could make out of all the foreign business you could get would not pay a one-hundredth part of the cost.

Mr. BROWN. What would it cost the Government to make the change to-day in their shops to the metric system?

Mr. SELLERS. Nobody could tell.

Mr. BROWN. Nobody could estimate that?

Mr. SELLERS. No, sir.

Mr. BROWN. It would be millions?

Mr. SELLERS. Millions; yes, sir. That is only a guess. You can not tell; but the worst of it is that it stops product. You can not make changes without stopping product.

The CHAIRMAN. The hour of 12 o'clock has arrived. I do not know whether the members of the committee desire to stay here any longer or not.

Mr. SHAFROTH. Let us hear Mr. Sellers's paper through.

Mr. SELLERS. Would the profit on all the foreign trade we could hope to attain by such a change amount to an appreciable percentage of the cost of the change? The time required to effect such a change would be lost to us collectively as a nation, as it would be to the individuals of it, and the end would be that the new standard of size would not be as valuable to the mechanic as the one we had discarded.

I feel perfectly sure that the meter, as a measure for the mechanic, is not comparable to the foot and the inch. Then again, the meter treats everything decimally. The curious thing about it is that we have ten numbers to note any sums that we please, and we can make fractions of halves, quarters, sixteenths, thirty-seconds, and sixty-fourths of an inch, or you can make a third, fourth, fifth, sixth, or seventh, but of those fractions four out of the ten must be expressed decimally. You can not make the decimal of a third.

The CHAIRMAN. If it were more convenient, why could you not halve or quarter or eighth or sixteenth or thirty-second a centimeter or a millimeter?

Mr. SELLERS. Because its divisions do not enable you to do it.

The CHAIRMAN. Why not? In France they have the millimeter or centimeter, or whatever it may be, and they halve it or quarter it, and so forth, just as we do with our measurements and weights.

Mr. SELLERS. I will give you an example. Suppose you want to say what is a third of a meter. How much is a third of a meter?

The CHAIRMAN. Suppose you want to say a nineteenth of an inch.

Mr. SELLERS. It is the nineteenth of an inch. A third of a meter you only get by dividing it into three.

The CHAIRMAN. It is the same way with a nineteenth of an inch.

Mr. BROWN. If you say a third of a meter, do you not destroy the metric system? Is not that getting away from the metric system?

Mr. SELLERS. Yes; you are expected to express everything decimally.

Mr. BROWN. You have to come back again to vulgar fractions.

The CHAIRMAN. Nobody has claimed it is something you can not get away from. The question is as to convenience, whether you can do it or not.

Mr. SELLERS. We mechanics think it is a great deal better to halve and quarter and eighth and sixteenth than it is to try to express it the other way.

The CHAIRMAN. I see that you mechanics are divided about it.

Mr. TOWNE. You have not yet heard fully from the mechanics of the country.

The CHAIRMAN. We have heard a great many mechanics before this committee during last eight years.

Mr. SELLERS. Unless a change of system or of machinery will enable the manufacturer to decrease the cost of production or to improve the quality of his product, the change will not only effect a total loss

of the discarded tools, but also a loss in product, because he can not make a change without diminishing his product while he is making the change. The injector department of William Sellers & Co. (Incorporated), was started in 1860 to make the Giffard injector, a French invention patented in this country, and our contract required that the smallest orifice in the instrument should measure by millimeters. The drawings, furnished by patentee, were to a metrical scale and proportions, and the work was started in accordance therewith. After the patent expired we could have changed every dimension to the metrology of the other parts of our works, but such a change would be expensive and would not have reduced cost of production or improved the quality of the product; therefore it has never been made.

That is what I say about this metric system. If we were occupied all over the country with it, if we were working with it, we then would be worse off than we are with the inch, but we would not change to the inch. It would cost too much, and so it would cost too much to change the old system of manufactures of this country to the meter.

Mr. SHAFROTH. Do you not recognize this, though, Mr. Sellers, that if the metric system were adopted there would be a transition from measurements from the English system into the metric system gradually, that the tools for the manufacture of the machines would keep on being used until some new machines were constructed and then you would construct that according to the metric system, and your tools according to the metric system.

Mr. SELLERS. Do you not understand that manufacturers can not have that sort of thing going on in their places? They have got to do one thing. They must have a great variety of work going on. It must be simplified as much as possible.

Mr. SHAFROTH. They do, however, have it——

Mr. SELLERS. When they can not help themselves they have to.

Mr. SHAFROTH. When the machine is ordered, you say yourself that machines are constructed often now according to the metric system, because there is a demand for it.

Mr. SELLERS. We started that particular business that way, but for forty years we have been all the time making more or less machinery for Europe, England, and the Continent, and we have never yet made anything in accordance with the metrical system.

Mr. SHAFROTH. What is it you use the metric system for in your factories? What do you manufacture in the metric system.

Mr. SELLERS. Do you know what an injector is, for feeding a steam boiler, putting the water into a steam boiler?

Mr. SHAFROTH. I have an idea of what it is, not a very accurate one, though.

Mr. SELLERS. It is an instrument for feeding the boiler with water. It has no moving parts in it. It takes the steam from the boiler and takes the water from the tank and forces that water into the boiler without any moving parts. It sounds a good deal like perpetual motion, but it is not anything like that at all. It is very effective, and it is used almost exclusively on locomotives now and a great variety of steam boilers. We undertook to make that in 1850. It was a French invention. Mr. Giffard did not stumble upon it. It was the result of study. He was satisfied there was a power there that

if properly directed would feed a boiler. The first instrument he made by calculation was effective. In order that he might determine what his royalties were our contracts stipulated that the small orifice in the instrument, which is the one which determines its capacity, the amount of water it would throw, should be measured by millimeters, and the drawings were to full size and in millimeters, which is just as good as drawings in feet and inches. We could make the machine to those drawings just as well as to any other, and we have the tools and appliances necessary to make those machines, and there are a great many.

Mr. SHAFROTH. And you do now make them in that way?

Mr. SELLERS. Yes; we make them now in that way. I have just stated that we could not change to the metrology of other parts of our work without costing a good deal, and the change would not enable us to do any more work nor would it improve the quality. Therefore we do not change.

Mr. SHAFROTH. You would not want to change the manufacture of that gauge from the metric system, would you?

Mr. SELLERS. No; I would not. I should keep on manufacturing them that way till the end of time.

Mr. BROWN. That was initiated on the metric system.

Mr. SELLERS. Yes; and all the tools and appliances necessary to make it.

Mr. BROWN. Is not that so in all cases where you use the metric system?

Mr. SELLERS. No; I imagine not. Especially in designing machinery there is a great deal of work where the binary divisions are of great consequence.

The defects of our system are slowly being corrected, as, for example, in the ton and its hundreds. The university convocation of the State of New York in 1866 appointed a committee of three to report "What measures, if any, the convocation should adopt in regard to a uniform system of weights and measures." It seemed to be the unanimous opinion of the committee that a report would be made favorable to the introduction of the French metrical system into general use. At the meeting of the convocation in 1869 the committee made a partial report and explained very fully the changes which an examination of the subject had produced on the minds of some of its members, whereupon the committee was discharged and a new committee appointed, consisting of two of the old members and a third who subsequently did not act with the committee. The committee recommended that the three measures of weight—avoirdupois, Troy, and apothecaries' weight—should be condensed into one, the avoirdupois, but no legislation concerning this recommendation appears to have followed. But granting that our system has its defects, it is in more universal use among English-speaking people than is the French metrical system in any country that has adopted that system.

I will say that that is absolutely true, that our system, defective as the metrical people say it is, is in more universal use among English-speaking people than the metrical system is in any metrical country.

The CHAIRMAN. It has been in use hundreds of years longer, has it not?

Mr. SELLERS. Yes; probably more than that.

Mr. CANDLER. The fact that it has been in use so many years longer would make it that much more dangerous to change, would it not?

Mr. SELLERS. Certainly it would. If the Government goes to establish the metric system by force, as this bill implies, that means war, and it will be just as uncertain as any other war. If the Government should win, our position in manufacturing will be worse than it is now.

The CHAIRMAN. Let me ask you a question. Supposing the Government should decide to use the metric weights and measures in its Departments. Will you indicate to us what the expense will be to you?

Mr. SELLERS. It might not be any.

The CHAIRMAN. Can you conceive how it would be any expense to you?

Mr. SELLERS. I can conceive how it would be a disadvantage to us, because if the Government should require that the machines that they want us to build for the Government must be built to metrical sizes we should simply decline to bid. We would not make them. We could not afford to.

The CHAIRMAN. You mean even sizes in metrical terms?

Mr. SELLERS. Do you mean that we should make them with the present size and specify what the dimensions should be in metrical terms? We might do that, but I do not see that that would be any particular advantage to the Government or to anybody else.

The CHAIRMAN. If it did, would it cost you anything in that event?

Mr. SELLERS. Yes; it would cost us the necessity of furnishing drawings to show what the sizes of those things were.

The CHAIRMAN. In other words, it would cost you the inconvenience of translation. Is that it?

Mr. SELLERS. Not that alone. We would have to provide the Government inspector with a drawing or something that would show what the dimension of the spindle and lathe, for example, is. Instead of being 3½ inches, it would have the same dimensions in metrical terms.

The CHAIRMAN. What would you have to furnish him?

Mr. SELLERS. We would have to make, probably, a tracing in which we could set down the dimensions and give him a blueprint of it.

The CHAIRMAN. You would make the tracing in any event, would you not?

Mr. SELLERS. Oh, no; we made those years ago.

The CHAIRMAN. Would you not leave it to the Government inspector to determine whether or not it met with the specifications?

Mr. SELLERS. We would have to.

The CHAIRMAN. Then why would you be required to do anything?

Mr. SELLERS. The probabilities are that the Government would call for certain dimensions in metrical terms, and if it was something that we had made theretofore, and we had our tools and appliances for making it, we should not want to change, because it would mean a loss to us more than we could possibly make up.

The CHAIRMAN. If the Government ordered a machine in different dimensions and you furnished the machine and it conformed in parts to those dimensions, that would be all there would be of it, would it not?

Mr. SELLERS. I want to know what good that would be; what benefit it would be.

The CHAIRMAN. I am not talking of what good it would be.

Mr. SELLERS. But that you are bound to give us.

The CHAIRMAN. That may enter into the proposition. I am not contending that, but I am trying to find out what the additional cost and expense would be to you.

Mr. SELLERS. Well, that would be impossible to tell, because you can not tell in this way what the interruption to the cost of your business is. Your profit would fall off. You see, successful manufacture means that you go on, right straight ahead. Every man about your place knows exactly what he has to do next; and any interruption means loss of profits.

Mr. LANNING. As I understand it, Mr. Sellers, if the Government should require you to make a machine which had in it bolts that were, say, half an inch in diameter, the diameter of those bolts expressed metrically would be $519\frac{22}{72000}$ of a meter.

The CHAIRMAN. Could you not state it in meters?

Mr. LANNING. But as I understand Mr. Sellers's point, it is that the Government would ordinarily, he supposes, call for meters expressed in an even number of meters.

Mr. SELLERS. Yes.

Mr. LANNING. But I call your attention to the fact that as I understand it a bolt a half inch in diameter expressed in metrical terms would be $519\frac{22}{72000}$ of a meter. Is it not true?

The CHAIRMAN. What would it be in rods?

Mr. LANNING. I have not figured that out.

The CHAIRMAN. If you are expressing the size of a bolt in meters why do you not also express the size in rods or miles?

Mr. LANNING. Because that would be utterly impracticable, as I understand.

Mr. BROWN. What would you call it under the metric system?

The CHAIRMAN. If it was an inch bolt it would be 25 millimeters, would it not?

Mr. LANNING. No; not exactly.

The CHAIRMAN. Perhaps not exactly.

Mr. LANNING. It has to be exact, Mr. Chairman.

The CHAIRMAN. I undertake to say that these standard sizes of bolts do not conform to any very exact measurements.

Mr. BROWN. Mr. Chairman, I saw the other day an order from the Government for 200,000 pounds of steel, and the size given, if I remember correctly, was 0.7877. Of course if they were exact in that they would be more exact under the metric system.

The CHAIRMAN. How many kinds of gauges are there to measure the thickness of steel, etc.?

Mr. BROWN. There are two gauges. There is the old English gauge and the Brown-Sharpe gauge. Those are all I know of; but most of them now are stated in decimals of an inch.

The CHAIRMAN. I was looking at a table in a book that was submitted here the other day in reference to the sizes of pipes, and I have taken a copy of the table, or a part of it. It gives the inside measurements, the outside measurements, and their equivalents. It is a very interesting thing to look at. It gives the different sizes as named and what they mean.

Mr. TOWNE. There is a very simple explanation of those odd sizes, Mr. Chairman.

The CHAIRMAN. Those are not odd sizes.

Mr. TOWNE. I mean the fact that they run into decimals.

The CHAIRMAN. They run into decimals whether you express them in our system or in the metric system.

Mr. TOWNE. That is true.

The CHAIRMAN. They are not intended to be just exactly what they are expressed as being. I apprehend it is the same way with bolts, although I do not know.

Mr. TOWNE. No; the same conditions do not exist.

The CHAIRMAN. There seems to be no real reason for very precise measurements in the matter of bolts any more than in pipes.

Mr. TOWNE. The measurements are exceedingly accurate in pipes as to the external diameter where the thread is.

The CHAIRMAN. Look at that table.

Mr. TOWNE. But you will find the standard which has been adopted is in use by all pipe makers in this country.

Mr. SHAFROTH. I think you had better put that in the record.

Mr. TOWNE. I think it ought to go in.

The CHAIRMAN. According to the metric system, the actual inside measurement is 0.364.

Mr. TOWNE. It is the external measurement that is the basis. The internal measurement is accidental.

The CHAIRMAN. Take the outside, then, of the same piece of pipe. It is 0.540.

Mr. TOWNE. In other words, it is a little over half an inch outside diameter. Would you like to know the reason for that?

The CHAIRMAN. There may be a reason for it.

Mr. TOWNE. There is a simple one—a historical reason.

The CHAIRMAN. What is the reason for it?

Mr. TOWNE. The reason is that originally "gas pipe," as it is commonly called, was made by certain interior diameters with the material that was available in the early days of the industry. As the industry developed and better material became available, the thickness of material in very small sizes was largely reduced. That resulted in the development of an internal diameter much bigger than the original one, and the external diameter had been adopted originally in order to obtain a certain interior diameter and the necessary thickness of metal. Industrial conditions had changed so as to permit the making of the pipe of thinner material and of better quality, but the original external size had become established, and it was more convenient to retain it.

The CHAIRMAN. These variations seem to extend here all the way through, with reference to internal and external dimensions.

Mr. SHAFROTH. The manufacturers do not have any difficulty because they are expressed in a long line of decimals, do they?

Mr. TOWNE. Not a bit.

Mr. SHAFROTH. Or in the conversion from the English system to the metric system?

Mr. TOWNE. No, sir.

Mr. HEDGE. Take a locomotive that runs out of the depot down here. I suppose that was made under the American measurement. Is there a man who is competent to give the specification of that

locomotive according to the American system of measurement who is not equally competent to give the specification in the French system?

Mr. TOWNE. He is perfectly competent to do so.

Mr. HEDGE. Why could he not do it beforehand?

Mr. TOWNE. Just as easily as a clerk who is competent to state a bill of cloth or calico in dollars ought to be competent to state it in pounds, shillings, and pence.

Mr. HEDGE. When the Pennsylvania Company wanted to build that locomotive originally, if they had wanted to make their specifications according to the metric system, would it not have been easy to translate it back into the English system?

Mr. TOWNE. Perfectly. There is no trouble about translation. A good many of us can translate from one language to another but can not speak the other.

Mr. HEDGE. That is where we unpractical men, who do not build machinery, can not understand the difficulty you would have in changing your tools.

Mr. TOWNE. I did not mean to interrupt, Mr. Sellers.

Mr. SELLERS. Not at all.

Mr. HEDGE. I should like to know why they could not build that locomotive up there in Philadelphia, or wherever they build them, on metrical specifications?

Mr. TOWNE. They can; perfectly.

Mr. HEDGE. With their present machinery?

Mr. TOWNE. They can; but there are good reasons why they do not want to and why it would be very expensive.

Mr. HEDGE. That is what I am after.

Mr. TOWNE. I know it is, gentlemen. I know that is what you are after. I have no doubt you all want to get at the facts in this matter as affecting American industries. I am here to speak as the representative of the Merchants' Association of New York and also as the president of the Yale & Towne Manufacturing Company, which is engaged in one of the metal-working industries, and I want the opportunity of doing whatever is agreeable to the committee. I do not want to submit a written argument; I prefer to present a verbal argument. I know what I want to say, and I can say it more clearly in that way.

The CHAIRMAN. We would like to have you do that. Now, tell us when you come before the committee why it would cost the manufacturer more to make that engine just as it is if the dimensions were expressed in one system rather than in the other.

Mr. TOWNE. I will admit at once, in answer to that question, that a locomotive can be built just as well to metric measure as to the English measure after you are organized for doing it, just as, to make an illustration from another source, I believe firmly that the single-tax theory of Henry George is the soundest one ever promulgated, and I wish this country, or the municipality in which I am interested, could start on that basis. We are very nearly there, but not completely; but the difficulty is to get the bridge to pass from the present condition to the new one, and no one has yet constructed such a bridge or shown, even, how to construct it, and we do not seem to be able to do it.

The difficulty here is the same. If the metric system had been in existence in this country from the time modern industry began—less than one hundred years ago, or a good deal less—so that all the vast capital we have in the plants for our productive industries had grown up with the meter or the millimeter as the organic base or standard of measurement, there would be no question in the world. It is the transition. It is to get away from what we have now to something new, and wiping out all the vast property interests which exist, and exist to an extent, gentlemen, which I believe you have not yet realized.

Mr. SHAFROTH. Do you think it would have been wise to adopt the metric system at the time John Quincy Adams wrote his report in 1814?

Mr. TOWNE. I think it would have been a great deal wiser if France and England and America had appointed a commission at that time to study the whole subject, and had the advantage of even a larger contribution of human intelligence to this subject than France had at that time. But remember what France did. It took France, after years of previous agitation of the matter, such as we are having here, eleven years from the time when, in 1790, she appointed her first commission of five to study the subject, until the law of November, 1801, became effective, under which the metric system was established, and it has taken her a century to get the system established so far as it is to-day. As Mr. Sellers has said, it is not yet fully in use.

Mr. WARRENER. Is it not a fact that the English wanted the French to make their meter 40 inches long instead of 39.37 in order that they could preserve their inch in other measurements?

Mr. TOWNE. If they had done that this whole question would have been solved. There would have been a direct relationship between the meter and the foot. We have a more convenient unit than the others, and some day, perhaps, one will be harmonized with the other; but to-day, gentlemen, the English-speaking countries—the United States and the British Empire—have more capital invested and more people engaged in industrial pursuits, based on the English standard of measurement, the inch, than all the metric-speaking countries put together have on the basis of the metric system.

The CHAIRMAN. How do you account for the evident disposition of the people of England to go to the metric system?

Mr. TOWNE. I question its existence. So far as my reading goes, and it is large, such disposition does not exist.

The CHAIRMAN. We were told that in 1895 a select committee appointed by Parliament, after extensive hearings, reported 16 to 1 in favor of the compulsory adoption of the metric system by Great Britain; that many English statesmen pronounced themselves very strongly in favor of it. We are also told that in the last year, or perhaps the year before, the colonial premiers of the British Empire, after considering the subject, unanimously passed a resolution advocating the compulsory adoption of the metric system in the British Empire. We are also told that in Toronto last year, at a meeting of the representatives of about 600 chambers of commerce extending over the whole British Empire, by a unanimous vote they passed a resolution favoring the compulsory adoption of the metric system by the British

Empire; and I have the names here, sent me by the secretary of the Decimal Association of Great Britain, of nearly a majority of the members of Parliament—259, I think—and of several others who were not willing to give their names, who had signified to the Decimal Association in writing that they would favor the compulsory adoption of the metric system for Great Britain. That would indicate some sentiment looking to the adoption of the metric system in that country.

Mr. TOWNE. It is a very fair argument, Mr. Chairman, and one that I should like to answer, if I may.

The CHAIRMAN. The question I am asking is how you account for this apparent sentiment there?

Mr. TOWNE. In this way: To begin with, when I first had occasion to think of this question I was an advocate of the metric system. Most people are. Academically it is the obvious thing for us to do. It was only after I had occasion to consider the subject and to study its practical bearing upon interests that I know of and am concerned with that I began to doubt, and before long that doubt turned into certainty that it would be nothing short of a national misfortune to this great industrial country to abandon its standards of length.

Now, if you talk of standards of value, if you want to change our currency to the French system or to the English system or the German system, that is easy. We can do that in a year's time. We will all get used to it and there is an end of it. If you want to change our units of bulk—and they need it, they are confused—and our units of weight, they can be very well reconstructed, and a commission for that purpose would be a very admirable thing. All of these relate to transactions of the present or the future. They have very little relation to the past. But when you come to standards of length, the past is involved, and the standards of the past will endure for centuries in the future. France has found this out, and Germany has found it out and realizes it to-day; it is a more serious fact in this country than in any other industrial country. Why? Because we are the greatest industrial country in the world.

The CHAIRMAN. We are told by the opponents of this system——

Mr. TOWNE. But I have not answered your question yet, if you will pardon me.

The CHAIRMAN. Very well.

Mr. TOWNE. The array of preference for the metric system that you have cited in England can be paralleled in this country. I fancy if you should take a poll of the members of Congress you would find a majority of them who would say, "Yes; let us vote for the metric measure;" but how many of them are concerned in the practical application of this question to industrial management? How many members of Parliament are concerned? What do you say as to the opposite fact, that the members of English manufacturing organizations and of English engineering organizations, where they have had these discussions, have developed not only no unanimity, but a broad divergence of views, with a decided majority in strong opposition to the change. For example, the British Institute of Electrical Engineers, in their meeting of January and February, 1903, had a long discussion of this subject by some of the ablest scientists in the world, men whose names are of international renown. Lord Kelvin was one of them. It developed there that there was this same divergence of

views. The scientific men, the men who deal only with science in its theoretical form, not in its application to industry, were most of them in favor of the metric system, but not all. Those who had to do with the practical application of science to the applied arts were almost to a man opposed to it.

Mr. SHAFROTH. How do you account for the fact, though, that there is not a single country that has adopted the metric system that contemplates adopting the English system?

Mr. TOWNE. Why should they?

Mr. SHAFROTH. Does not that show the superiority of the metric system?

Mr. TOWNE. No, sir; it shows the superiority of an established standard, and no country in the world has ever had what America has to-day in this respect.

Mr. SHAFROTH. Do you not think there would be a great benefit in a uniform standard for the world?

Mr. TOWNE. Yes; as there would be in a uniform language.

Mr. SHAFROTH. Do you not believe that the postponement of this question and the adoption of it is simply going to involve more expense to manufacturers to make the change?

Mr. TOWNE. No, sir.

The CHAIRMAN. How do you account for the fact that in every country that has not the metric system there is more or less tendency toward it?

Mr. TOWNE. That is easily answered. The reason why France adopted the metric system, and the reason why Germany adopted the metric system eighty years later, was that each had a chaos of measures. They had no standards. They had a multiplicity of measures of all kinds. They began to realize, as modern industry was then dawning, the importance, the vital necessity, of a uniform standard, and they went to work wisely to devise one. Germany took the question up in 1860, and after eleven years of discussion—by accident it happened to be the same time that France took—in 1871, during the Franco-Prussian war, Germany adopted the metric standard. She had then forty different States, and more than half of them had different standards of measurements of all kinds, including currency. She wanted uniformity.

Why should she not adopt the metric system when her neighbor on the west had already got it established, and also some of the other adjacent countries? We have no such condition of things. To-day from one end of the land to the other, and throughout the whole British Empire, we have an absolute, identical, uniform standard of length. The thing France wanted, the thing Germany wanted, we have. For us to do at this stage, under present conditions in this country, what France did in 1801 and Germany in 1871, is to reverse the process and to substitute for a uniformity of standards, which they sought to obtain, a multiplicity of standards where we have already uniformity.

Mr. SHAFROTH. Are we not getting a multiplicity of standards by not adopting it? For instance, the chemists all use now the metric system in our own country.

Mr. TOWNE. Yes.

Mr. SHAFROTH. And others, as Mr. Sellers has said, use it. It is forcing itself by reason of the merits of the system, and might not

that produce the confusion, and will not the confusion be removed by our adopting the metric system?

Mr. TOWNE. No, sir; for this reason: The fact that chemists find it more convenient to use the gram as the basis of their measurements than the English grain has no practical bearing on the engineering and metal-working interests of this country, or the textile industries. The fact that opticians and oculists have seen fit to adopt the metric system of determining the focal length of eyeglasses and opera glasses has no bearing upon the wood-working industries or the coal-mining interests or locomotive building. Let them have their standards. The law permits that now.

Mr. SHAFROTH. But that produces a confusion.

Mr. TOWNE. No; no confusion at all, because there is no interrelation between those industries.

The CHAIRMAN. Is it not a fact that we are gradually increasing our intercourse with other nations—that other nations and ourselves are gradually becoming closer together?

Mr. TOWNE. Yes.

The CHAIRMAN. Our trade relations as well as other relations are becoming very intimate.

Mr. TOWNE. Mr. Chairman, for thirty years my business has included a small measure of export trade, which is growing and which is now quite substantial. We do business with every part of the civilized world, practically, and especially with Europe. The products we manufacture are Yale locks, builders' hardware, small metal work, and hoisting machinery. We have never yet, in the thirty years of my experience, had this question raised of the metric system as related to the dimensions of our products.

The CHAIRMAN. You make a lock and you make a key to fit it, and it does not make any difference what system is used.

Mr. TOWNE. That is right, and we make the dimensions of our lock, say a line of padlocks, in fractions of an inch, an inch and a quarter, an inch and a half, 2 inches, 3 inches, and so on. The buyer in the metric market does not care anything about that.

The CHAIRMAN. He wants so many locks.

Mr. TOWNE. No; he wants an approximate size. He takes up our catalogue, sees the size he wants, finds the price satisfactory, and he buys it. He does not care anything about the standard of measurement we use in making that lock.

Let me ask, how much has the fact that the greater part of our vast imports during past years, and at the present time, are made in metric-measuring countries interfered with our importing them? What do we care, when our wives buy a piece of silk ribbon, that it was made on a loom in which all the measures are supposed to be metric, but are not?

The CHAIRMAN. Here is an illustration. The other day I was riding with a man between here and my home. He was a manufacturer, I think, of copper work of some kind. He told me that he sent over to Germany for a case of inlaid work, and he gave his measurements in the foot and left the translation to the manufacturer. When it came back it was too small for the place he wanted it for. He realized then that the foot is not a definite unit, that there are many kinds of foot, and that they did not use the same kind

of foot he had used in measuring the space that he wanted to fill, and the piece of inlaid work was worthless.

Mr. TOWNE. And why? I was in the city of Cologne, in Germany, last summer, and in a hardware shop on the leading street there—I happen to remember the name, Schmidt & Meldan—I looked at what we would call a 2-foot rule, which is there, of course, the meter. On one side was the meter and millimeter, on the other feet and inches. What foot and inch? You are asked that question over the counter. Do you want the Rhenish inch or the Westphalian inch or the Dresden inch? They have three foot measures in use in that one locality, together with the meter.

The CHAIRMAN. I understand there are some 260, I think it is, units called the foot, of different values in the world.

Mr. TOWNE. Yes.

The CHAIRMAN. Would it not be a great convenience and a source of satisfaction and saving, we may say, if we had the meter substituted for all those?

Mr. TOWNE. If we had uniformity, yes; it would be a great convenience if we had a uniform measure.

Mr. SELLERS. But they haven't that. They have no uniformity in metrical countries.

Mr. TOWNE. Mr. Chairman, Mr. Sellers has referred to one of the points I want to bring out when I have an opportunity to address the committee more at length than I have to-day. He does work in his establishment as we do work in ours. We do not use a rule to measure by. You can not do fine work in that way. The human eye is not competent to see measurements with the precision and accuracy that we must have to make work interchangeable and economical. What we work with is our gauges. A workman does not need to know whether those gauges are measured in millimeters or feet or any other standard. One of the best and largest investments we have is in those appliances.

Mr. HEDGE. I want my question answered definitely right there on a locomotive. I give you my specifications in the metric system. I want this locomotive built. Your man can translate it?

Mr. TOWNE. Yes; perfectly.

Mr. HEDGE. Very well. Why could he not go ahead with that locomotive?

Mr. TOWNE. So he can, but what is the advantage?

Mr. HEDGE. Leaving that out, what is the disadvantage?

Mr. TOWNE. Here is the disadvantage.

Mr. HEDGE. I have no doubt there is a disadvantage, but I do not understand what it is except the trouble of translation.

Mr. TOWNE. The trouble of translation? Suppose, for example, we should decide to adopt the French monetary system instead of ours, but not change real values; when you wanted a 2-cent postage stamp would it be convenient for you to say you wanted a stamp of the value of 0.10336 franc?

Mr. HEDGE. No; it would not.

Mr. TOWNE. But that is what you would have to say to be accurate.

Mr. HEDGE. We are talking about manufacture now.

Mr. TOWNE. I am talking about manufacture, and when you propose to me, in my manufacture, to substitute for a measurement in the simple multiple parts of a standard, where I now use one or two, or, at the very most, three figures to represent it—a new standard under which I have got to use 6, 8, 10, or 12 decimal figures, then I say you are getting in an awful tangle of figures that is going to mean error, trouble, confusion, and expense. We can't do it.

Mr. HEDGE. You do not get down to less than a thousandth of an inch, do you?

Mr. TOWNE. We work in some things to the ten-thousandth of an inch.

The CHAIRMAN. Ordinarily you only require three decimal figures?

Mr. TOWNE. Yes. Gentlemen, there would be no trouble about using the metric system instead of the English if it were established, although it is not as good; the units are not as convenient. The transition is the difficulty.

Mr. SHAFROTH. Is there not a difference now between the British inch and the inch we use?

Mr. TOWNE. No; they are identical. It is a theoretical inch you are talking about.

Mr. SHAFROTH. What is this geometrical inch?

Mr. TOWNE. That is theoretical.

Mr. SHAFROTH. It is not the inch that is used?

Mr. TOWNE. No, sir.

Mr. LANNING. What is it based on?

Mr. TOWNE. On a fraction of an earth measurement, and the demonstration you refer to is to show that that inch is almost identical with the actual inch.

Mr. LANNING. I understand it is a part of the polar radius.

Mr. TOWNE. Yes.

Mr. LANNING. Is there such a thing as the geometric inch?

Mr. TOWNE. The name exists; yes; but there is no legal standard of that kind.

The CHAIRMAN. If we were basing any argument on the theoretic meter——

Mr. TOWNE. We do not, Mr. Chairman. We manufacturers do not care anything about the relation of the standard of length to the rotation of the stars or the sun or the moon. All we want is something that is standard.

The CHAIRMAN. Now, Mr. Sellers, you go ahead and finish your statement.

Mr. SELLERS. The special legislation in this bill concerning the Departments of the United States is unnecessary. The clause which states that "from the 1st day of July, 1902, the metric system of weights and measures shall be the legal standard of weights and measures recognized in the United States" would seem to require all the Departments of the United States to conform thereto, as well as all the other parts of the United States.

This being the case, what object have the advocates of the metric system for inserting this clause concerning Departments in the bill? Simply that Congress could enforce the law upon its Departments, and the introduction there would react upon the country at large, to induce a more extended use of it. The argument already stated

against the destruction of the inch standard is just as important for the Departments of the United States engaged in mechanical pursuits as it is for similar pursuits throughout our country.

Such legislation in favor of the French system of metrology, at a time when our mechanics are more than satisfied that our own basis of measurements is superior to the French, is unwise. The defects of that system are clear, and if we are to have any change let it be in a direction that will avoid the mistake of the French metric system. This system is claimed to possess great advantages for physicists, chemists, electricians, and certain branches of trade. Everyone is now free to avail himself of these advantages, but the new metrology, to be acceptable to all, must conserve our inch and its multiples, our binary divisions, our duodecimal measurements, and our fractional quantities. This might be accomplished by making the meter 40 inches long instead of 39.37 inches; increase the length of the French meter 0.062. Twenty-five millimeters would then exactly equal 1 inch, and the increased volume of the cubic centimeter, which measures the weight of the French gram, would be 0.0448; that is to say, divide the French gram into 10,000 parts and add to it 448 of these parts to make the new gram. This would give us a decimal system of metrology as complete as that of the French, but it would not be a decimal system and nothing more, for it would combine the advantages of both systems, and weights and measures thereafter would be commensurate, however varied their names, their dimensions, or their uses. Our binary divisions, our duodecimal measures, and our tools of fixed dimensions would be maintained, and we should have added thereto a decimal system of weights and measures having a base common to all others.

It is claimed by the advocates of the French metric system that our system has a variety of weights and measures of different values under the same names, and to abolish these incongruities would be one of the advantages that would result from the adoption of that metric system. The report of John Quincy Adams in 1821 and the reports of the university convocation of the State of New York, 1866 to 1872, originated in the expectation that the French metric system would be adopted, but the investigations of both resulted in its rejection. These show that at no previous period in our history was it believed that the adoption of that system would be advantageous. Since then the development of our mechanic arts has been enormous, and it will not be pretended by anyone that a decimal system of metrology would be as desirable in these arts as our binary divisions, our duodecimal measures, and our fractional quantities. It would seem, therefore, that at no future period could it be expected a purely decimal system of metrology would be acceptable.

For this Government to adopt alone any modified metric system would be to provide additional varieties of weights and measures which would probably find few users. It would, however, be comparatively easy to remedy the difficulties arising from weights and measures of the same names but of different values in our system. Indeed, the report of the university convocation of the State of New York, above referred to, suggested a remedy for weights which should be acceptable to the extent indicated. There are other modifications desirable which might be attained through a joint commis-

sion appointed by the Governments of Great Britain and of the United States or by a commission of the latter only, legislation thereon to be concurrent in both nations before it would become operative in either.

Mr. SHAFROTH. As I understand you, you would believe in the adoption of the metric system if the meter were 40 inches instead of 39.37?

Mr. SELLERS. To what extent?

Mr. SHAFROTH. I mean adopting the system.

Mr. SELLERS. And abandoning our own metrology?

The CHAIRMAN. Taking the decimal system, I suppose he means, making the meter 40 inches.

Mr. SELLERS. I do not believe in that. I do not believe in the adoption of the decimal system for the engineer or for the mechanic. I consider it would be a great public misfortune to do it, and I think I know about that sort of thing.

The CHAIRMAN. You have said that would preserve our inch, and, while giving us a decimal system, would preserve our binal divisions?

Mr. SELLERS. It would give us a decimal system superimposed upon our present system. I should not wipe out our present system at all.

The CHAIRMAN. You would still retain our square measure, cubic measure, and all that?

Mr. SELLERS. Certainly I would.

The CHAIRMAN. And our tables of liquid measure, and all those—would you retain them?

Mr. SELLERS. Perhaps. As a system I would want to retain it. Some of its details could be amended to advantage, but to substitute the metric for our system would be a great public misfortune, in my judgment.

Mr. WARRENER. Mr. Chairman, may I suggest that the reason the English suggested 40 inches instead of 39.37, was because then the measures of lengths of the two countries would be commensurate; that they would be interchangeable to a great extent; that they are not interchangeable at all and are not commensurate at all now.

The CHAIRMAN. I understand the reason why they suggested it.

Mr. CANDLER. Mr. Sellers, did you state the extent of your experience—how long you have been engaged in this business in which you are engaged now?

Mr. SELLERS. No; I did not say anything about it.

Mr. CANDLER. Will you please state to what extent your experience goes and how long you have been engaged in it?

Mr. SELLERS. I have been in the machine business since 1838, when I first went at the business as an apprentice. I was an apprentice for seven years and then went to New England to take charge of a shop there.

Mr. CANDLER. And you have been in the practical machinery business from then up to date and are now?

Mr. SELLERS. Yes.

The CHAIRMAN. When did you first begin to manufacture this injector?

Mr. SELLERS. In 1860.

The CHAIRMAN. After you established your manufactory at Philadelphia?

Mr. SELLERS. Oh, yes.

Mr. BROWN. Mr. Sellers, your concern is one of the largest in the United States in this line of business?

Mr. SELLERS. No; not now. There are some of these combinations that are larger.

Mr. BROWN. I mean one of the largest in that class in the United States?

Mr. SELLERS. Yes; we were the first to be in that business, and we have been in it for more than half a century—in that particular business.

Mr. TOWNE. Mr. Chairman, may I speak to this question? Mr. Sellers is too modest. I have had the pleasure and honor of knowing him nearly all my life. For a short time I worked as an apprentice in his shop in Philadelphia, and I am in a position as an engineer and manufacturer to testify more freely than Mr. Sellers seems willing to do to the fact that no name stands higher in mechanical engineering in the United States than that of William Sellers. No American name is more widely known in Europe than his. He was one of the pioneers in this country in the standardizing and elevation of machine tools, the tools which build the machines which all other industries depend upon for their product; and at one time his concern was distinctly the leading and ranking one in the country in that field. It is still in the very front rank, although others excel it now in size.

Mr. Sellers's name is perhaps best known in connection with what is known throughout the world as the "Sellers standard screw thread." Years ago he took up the question of standardizing our screw threads, which were at that time in great confusion. Every machine shop had its own standard, and there was no uniformity. Work would not interchange from one establishment to another. Everyone recognized the desirability of a standard, and Mr. Sellers proposed, after long study and investigation of the subject, a standard system of screw threads. That was a report, I think, to the Franklin Institute, of Philadelphia. Was it not, Mr. Sellers?

Mr. SELLERS. Yes; in 1868.

Mr. TOWNE. In 1868 it was approved and adopted by the Franklin Institute first, and successively by American engineers and metal workers, until to-day it is the accepted standard of this country—accepted voluntarily, not under compulsion by legislation. The corresponding standard in England is known as the "Whitworth thread," designed and introduced by Sir William Whitworth. Those two systems of screw threads were practically the only two of the civilized world until the convocation at Zurich, which Mr. Sellers has referred to, which was held a few years ago, which was an attempt—not officially, not governmentally, but voluntarily—by leading manufacturers and scientists in metric-speaking countries to evolve order out of chaos in their countries, as Mr. Sellers had long before done it in our country, by standardizing screw threads on the metric system. What they did was to say that, out of the multiplicity of different standards and practice which then prevailed, here was one which, on the whole, combines the greatest advantages and the fewest

disadvantages, and we recommend it as the standard metric system of screw threads. So far as is possible, that is being adopted where the metric system has prevailed; but even in adopting that they have copied, approved, and adopted many of the features of the Sellers system.

Mr. SELLERS. The shape of our thread.

Mr. TOWNE. Yes; the shape of the thread. The Whitworth screw to-day, the English standard of screw thread, prevails very largely, and much more than the metric system, in metric-speaking countries, as the basis for screw threads, and the screw thread is the basis of measurement throughout the whole mechanical field.

The CHAIRMAN. I notice in a catalogue I have at least half a dozen screw threads that are called standard.

Mr. TOWNE. They are for different purposes, sir. The Sellers standard is for screw threads for bolts and nuts, which are the most important of all. There is another standard of screw threads for wrought-iron pipes, such as are referred to in that table you have there, what are commonly known as "gas pipes." There is another standard for wrought-iron or steel pipe of a thinner kind and larger diameter, which is used in steam fitting. They use it in boilers chiefly. There is still another standard used on brass tubing, which is quite distinct from the others, and there are some minor and special ones, and still another set of standards for very fine screws, such as are used in watch making.

The CHAIRMAN. So there are quite a large number of standards?

Mr. TOWNE. Yes; in any country—standards of different industries and different classes of products; but the essential thing, Mr. Chairman, is uniformity, whereby work made at one time by one establishment will fit together with work made at the same establishment at any other time, and still more that work made in one establishment at any time will go together with work made in any other establishment at any time. That is the condition of things we have got in this country, as the result of sixty or seventy years of effort, and it would all be wiped out and neutralized by changing the standard of length.

The CHAIRMAN. The metric people contend that there is no earthly necessity for interfering with screw threads.

Mr. TOWNE. They can not.

Mr. SELLERS. Then what do they do it for?

The CHAIRMAN. I do not understand that there is any proposition to do it.

Mr. SELLERS. That is just what they are trying to do now. As I stated, I think three years ago this convocation of scientists met, but they could not agree until three years ago.

The CHAIRMAN. I suppose that will always be a matter with the manufacturers themselves, as a matter of course.

Mr. SELLERS. They have varied in certain particulars. If this bill becomes a law it wipes it all out, and you may imagine how the mechanics of this country must regard it.

The CHAIRMAN. I would not think that would follow at all, Mr. Sellers.

Mr. SELLERS. That is because you do not know.

The CHAIRMAN. I do not profess to know, and when I find metric people and other people differing so widely I conclude one or the other of them does not know.

Mr. SELLERS. A good many of the metric people do not know anything else than the metrical part of it. They do not know anything about the actual practice.

The CHAIRMAN. The meeting will now stand adjourned until one week from to-day.

The committee adjourned until Thursday, February 11, 1904, at 10.30 o'clock a. m.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., February 11, 1904.

The committee met this day at 10.45 o'clock a. m., the Hon. William M. Lanning in the chair.

Mr. LANNING. Gentlemen, we will proceed with the hearing. Whatever may be said will be taken down by the stenographer, and although all the members of the committee are not here they will have in print all the views that the gentlemen desire to express. Mr. Towne, of New York, was here at the last session of the committee, and I think he was assured that he would have the first place to-day; so we will hear from him first. I understand there are three or four others who desire to be heard this morning, and we can give you, in all, an hour and ten minutes only, as we shall be obliged to go into the House at 12 o'clock. Therefore I suggest that you divide up your time so that you all may be heard.

STATEMENT OF MR. HENRY R. TOWNE, OF NEW YORK, PRESIDENT OF THE YALE & TOWNE MANUFACTURING COMPANY, OF STAMFORD, CONN., AND NEW YORK, AND REPRESENTING THE MERCHANTS' ASSOCIATION OF NEW YORK.

Mr. TOWNE. Mr. Chairman and gentlemen of the committee, I will be as brief as possible, and my argument will be partly verbal and partly by exhibits.

I stated last week that when I first considered the metric system I was in favor of its adoption from an academic point of view. The usual tendency in that direction is very strong.

Mr. LANNING. Before going any further, Mr. Towne, please state, so that we will have it on the record, where you are from and what your business is, and so forth.

Mr. TOWNE. I come from New York, and primarily to represent the Merchants' Association of New York; I appear also as president of the Yale & Towne Manufacturing Company, of Stamford, Conn., and of New York. And I am also a past president of the American Society of Mechanical Engineers.

When I took up this subject, however, Mr. Chairman, as a practical question, I first began to doubt the feasibility of making a change in our measures of length; and later that doubt became a certainty as I came to appreciate what such a change would involve in

my own industry and in other metal-working industries with which I am familiar by training and by profession.

The subject is a complex one. It involves the measures of length, of weight, and of volume. In engineering work measures of weight and of volume are of secondary importance, but measures of length are of primary and fundamental importance; and it is the effect of the proposed change upon our measures of length which we engineers and manufacturers object to and protest against most strongly.

There is a needless confusion in the English system of measures. We have, all told, ten tables of measures, nine of which are in active use. Six of those relate to weight and volume, namely, Troy weight and apothecary's weight, in which, however, the same pound, ounce, and grain obtain; and avoirdupois weight, in which there is a relationship with the others in respect to the number of grains to the pound. It would be a comparatively simple matter for a competent commission to reconstruct our system of weights, and, in place of the threefold system which we now have, to substitute a single one. This would be a very desirable improvement, and I think there would be very little objection to it; certainly not on the part of engineers.

In the matter of measures of volume we have a liquid measure with a gallon of 231 cubic inches, and a beer measure with a gallon of 282 cubic inches—practically not used now—and a dry measure, in which the bushel unfortunately has a fractional relationship to the cubic inch.

Now, these three measures ought to be easily merged into one, and standardized so as to conform to the British imperial measure of the bushel, which is slightly different from the American bushel, whereas the British pound, foot, and inch are identical with the American. With that slight change the British and American units of volume and weight could be brought into perfect harmony, and could be simplified into practically two measures—one of weight and the other of volume.

In measures of length we have nominally three tables—long measure, as it is called, covering all measures of length, in which the English and American base is identical; surveyor's measure, which is arbitrary, although it is based upon the foot, the surveyor's chain being 66 feet in length, and square measure, used for measuring surfaces of land, and so on. From square measure is derived our cubic measure, which relates to cubic contents or volume instead of to area or surface. Here again something could be done in the way of simplifying the tables and throwing out some of the needless units or multiples, such as the furlong, rod, and rood.

Now, most advocates of the metric system favor the substitution of it for all of our established measures. So far as engineers and manufacturers are concerned, it is the substitution of the French unit of length for our English inch to which we object. We object to it on fundamental business grounds, which are not theoretical nor academic, but intensely practical.

Why did France change from her old measures to the metric system at the beginning of the last century? It was because she had a confused—I can not say "system," but an absence of system—a multiplicity of measures in the different provinces, a confusion of measures, not closely related to one another, none of them well devised, and collectively causing such confusion as to entail a great burden upon

commerce and upon the industrial world of France. She wanted uniformity. Therefore she appointed a commission to study the question and to devise a new national system of weights and measures. Out of that effort resulted the metric system.

Why did Germany sixty years later do the same thing? In 1860, when Germany took up the subject, the name "Germany" was only a term; it did not cover a national organization. On the contrary, what was marked as "Germany" on the maps then comprised about 40 different States, more than half of which, I believe, had separate and different standards of weights and measures.

Germany was in the condition that France had been in, and Germany began in like manner to feel the need of uniformity. As France had appointed a commission, or a series of commissions, three in all, beginning in 1790 and ending in the adoption of the metric system in November, 1801, so Germany, in 1860, took up the subject and appointed a national commission to study it. By accident that commission took exactly the same time as the French commission had taken, eleven years, and it was not until 1871 that Germany adopted the metric system, and for the same reason which influenced France, namely, to obtain uniformity in her national standards. Having to make a change, Germany wisely adopted the system which France had already adopted, and which most of the Latin countries had adopted, because, though not perfect, it was good. While Germany undoubtedly could have devised, in 1871, a more perfect system than did France in 1801, she appreciated that the advantages of doing so would be less than the advantages of having a national system conforming to the national system of the adjacent countries.

We have no such condition of matters in this country, Mr. Chairman. We already have to-day what France sought, and what Germany sought, when they made their change. We have a national standard. We have uniform measures of every kind throughout the length and breadth of this land, and, with some minor exceptions, they are identical throughout the English-speaking world. In measures of length they are absolutely identical, from one end of the world to the other, among the English-speaking races.

This great fact exists to-day, and it is one of the best assets of the American manufacturer. You ask us now to throw away this great advantage in our industries and to substitute something else. We ask in return, What benefit do you offer us if we make this exchange? How shall we be better off after we have made it than we are now?

No one has presented any argument that I am familiar with which gives a satisfactory answer to this question.

The main argument for the change comes from scientists and theorists, from men who, with the greatest sincerity and with high motives, discuss this question from its theoretical rather than from its practical side. We agree with them, as a matter of theory, that there are some advantages to be derived from the change if it were feasible. But we reply to them that there are so many difficulties involved in the practical accomplishment of the change in every mechanical industry as to nullify all the theoretical advantages and to put in the other side of the scale an overwhelming weight of disadvantages.

When France made the change modern industry had not been born. Modern science was in its infancy. Even when Germany made the change, although science had made great strides and modern industry in Germany had begun to grow actively, no such condition existed in the applied arts as exists to-day in the United States. We are to-day undoubtedly the greatest manufacturing country on the earth. Our mechanical industries—of course I do not speak of agriculture, the greatest industry of all, and the foundation of all—our mechanical industries are based primarily, every one of them, on the machine-tool industry. This is the industry which makes the implements of all the others. This is the industry which takes the raw material, the metals, and converts them into the implements and machines, with which every one of our manufacturing products is produced.

It is the men identified with the metal-working and metal-using industries, in all of their vast ramifications, who oppose the proposed change in our unit of length. Every element of those industries, Mr. Chairman, is built up on the English inch as its cornerstone, and if you pull out that cornerstone the edifice will fall. It can be rebuilt, of course, but at infinite cost, spread over at least several generations of human life; and all, I ask, for what purpose? Again we ask you. What is the benefit which justifies this sweeping change and this obliteration of values, compared with which the recent calamity in Baltimore is a bagatelle? A little later I am going to offer some ocular evidence in justification of this strong statement.

The argument is made that we need this change in order to foster our export trade. That trade is already vast and increasing, is of vital importance to the country, and, above all, to our manufacturing industries.

Anything that would aid it is certainly worth most careful consideration. But in the judgment, I believe, of the great majority of those who are concerned in the export trade in manufactured products, the abandonment of our present standard for the French standard of length would not only be of no benefit to us, but would impose a most serious handicap upon us.

The best evidence of this is that no demand for this change comes from those who are directly concerned in our export business. Since 1866 it has been permissible, under the laws of the country, for anyone to use the metric system if he pleases, and transactions based upon it have been legal; yet the mechanical industries of the country to-day are not using the metric system, I venture to say, in one-tenth of 1 per cent of their operations. If there was this alleged benefit to be derived from it, why have not those industries voluntarily availed of it? Instead they have rejected it. Surely this fact is proof that the change is not needed for the fostering of our export trade.

The import trade of this country in manufactured products of other nations is vast. All of those products which come from continental Europe—that is, the major part—are made in countries using the metric system. How much has this fact retarded or interfered with our use and importation of the manufactures of those countries? Absolutely not an iota. We never hear of it. Some manufacturers in those countries are so dependent upon our market that, if their control of our market here depended upon this question—that is,

depended upon adapting their products to the standard of length in use here—they would promptly discard their own measures and use our measures. But do they do this? I am prepared to answer that question in the negative after much reading and study of the subject and many visits to Europe and inquiries among the industries of the countries there.

Mr. GAINES. Mr. Witness, let me ask you a question there. We have sold millions of our machines in foreign countries. That machinery will have to be repaired from time to time, when it wears out and breaks, or new machinery supplied from this country. If we should change to the metric system here, and hereafter make our machinery in the metric system, would it interfere with the supplying of those parts in those foreign countries?

Mr. TOWNE. Yes, sir. These implements, these machines, would become depreciated in value in this, that they could be repaired only by parts made to the English standard, which latter could not be used with machine tools made under the metric system.

Mr. LANNING. Would it be impracticable, Mr. Towne, in supplying orders from foreign countries for these parts of machinery which are intended for purposes of repair, to which reference has just been made, to give measurements in the equivalents of the present system?

Mr. TOWNE. No, sir. It would not be in the least impracticable, but it would be very inconvenient.

Mr. LANNING. If not impracticable, why would it impair our trade with foreign countries in that respect?

Mr. TOWNE. The answer to that is somewhat complex, but I will state it as briefly as I can. At the present time a certain part of one of these machines has a standard size based on the English inch, which size is gauged and determined by an instrument such as I have here [holding up a gauge]. We could state that size, of course, in its metric equivalent; but as we came to design new machines, using the metric system as our customary language of dimension, in stating measures of length we would wish to get rid of the inconvenient fractions which that would involve, and naturally we would do what all metric-using nations have done, namely, make the unit of measurement in machines some even multiple of the millimeter or of the meter.

You have got to do one thing or the other, Mr. Chairman. You have got either to maintain existing absolute sizes, and state those sizes in metric terms, in which case we get decimals running into seven, eight, nine, or even ten places, some of them, with all the interminable array of figures which that involves, and the resulting danger of error and inaccuracy, or else, to get the full advantage of the metric system, you have got to change your actual sizes into the nearest even equivalent in metric measurements. But when you have done the latter, you have destroyed all of your existing implements of measurement, you have made it impossible for work to interchange between old and new machines, and you have subjected yourself to the vast expense of duplicating your entire equipment of gauges and special tools.

Mr. LANNING. Would it ever be necessary, in using these equivalents and in practical business affairs, to use decimals to the extent you have suggested—seven, or eight, or nine, or ten decimals?

Mr. TOWNE. It would, Mr. Chairman. I can best answer that question by taking up now what I consider the most important part of my argument.

Mr. WILLIAM LODGE, president of the Lodge & Shipley Machine Tool Company, of Cincinnati, Ohio. May I ask one question here, Mr. Chairman, in connection with Mr. Towne's answer to the gentleman's question as to equivalents? In order to make it clear to you, suppose you had on your shelves $10,000 worth of those gauges, which is quite likely——

Mr. TOWNE. We have many times $10,000 worth of those gauges on our shelves.

Mr. LODGE. Would it be possible to use any one of them as a gauge under the metric system?

Mr. TOWNE. Not one.

Mr. GAINES. How much would it cost for you to change your machinery from your present system—the American system—to the metric system? And when you answer that—if you possibly can make the calculation—tell me how much it would cost the manufacturers of the United States—all the manufacturers—to change their machinery from the present system to the metric system?

Mr. TOWNE. I can only give an opinion.

Mr. GAINES. That is what I want.

Mr. TOWNE. I will state, to cover all your question implies—the complete substitution of the metric system for the English system of weights and measures for all of our manufactures—that a thousand millions of dollars would not pay for it.

Mr. GAINES. Would it practically bankrupt the capital invested in machinery now?

Mr. TOWNE. No, sir; because the American manufacturer would not acquiesce in the change.

Mr. GAINES. Suppose we make him do it?

Mr. TOWNE. He is not going to allow himself to be wiped out of existence in his business.

Mr. GAINES. But suppose we put a penalty or fine upon him?

Mr. TOWNE. Then he will elect new members of Congress who will execute his will. [Laughter.]

Mr. GAINES. Gentlemen, I move that we table this bill right here, and quit taking testimony. [Laughter.]

Mr. LANNING. Do you want to come back, Mr. Gaines?

Mr. GAINES. We have got down to the milk in the cocoanut right here. We are not going to pass this bill, gentlemen. [Laughter.]

Mr. TOWNE. Now, Mr. Chairman, I think from what I have read of the discussions heretofore had before your committee that the impression prevails that this change would be accomplished to a large extent by the withdrawal of the carpenter's 2-foot rule and the substitution therefor of the metric rule. I want to illustrate, by these exhibits, the fact that, in practical metal working, we do not use the 2-foot rule. We work with gauges and sizing tools. I want, briefly, to illustrate what these gauges represent [holding up a gauge and pointing to others on the table]. Here, gentlemen, is a file of blueprints [pointing to a file on the table], showing on each page from two to six gauges; nothing but gauges, all relating to a single product in the Yale & Towne Manufacturing Company's works.

That product is a common dial or combination lock used on safes. It is only a trifling part of our total product, and this is the gauge equipment required for that one product.

Mr. GAINES. How much would it cost to reproduce that if you had to change it to the metric system?

Mr. TOWNE. This set of gauges?

Mr. GAINES. Yes, sir.

Mr. TOWNE. Not less than $5,000 or $6,000; probably $10,000. I am speaking offhand. That product is just a small part of our total business. Every dimension on every one of these many sheets is in decimals of an inch; always in hundredths, more often in thousandths, sometimes in ten-thousandths. For example, here is a gauge used in making one part of a Yale lock of a certain size—a small size. This is the article [exhibiting]. Here is the gauge by which the workman ascertains whether the diameter of that piece is right or wrong. The proper diameter is forty one-hundredths of an inch. This gauge is made of hardened steel, ground accurately, and this hole is exactly forty one-hundredths of an inch in diameter, and the piece should go into it snugly [indicating]. This other hole is one-thousandth of an inch smaller. The article must not go into the latter gauge. If it does, it is rejected.

The limit of error, or of tolerance as it is called, in this particular article, is one one-thousandth of an inch. We do our work with gauges of this kind, not with a 2-foot rule, and not even with a steel rule. To produce such a gauge as this we do use a rule or scale. We use a scale such as this [exhibiting], graduated down to the ten-thousandth part of an inch; but we have others which give the one hundred-thousandth part of an inch.

Mr. GAINES. What is that called?

Mr. TOWNE. A caliper. You close these two sliding pieces until they fit upon the object to be measured, and read on the scale the resulting length, this vernier arrangement enabling the workman to read down to the ten-thousandth of an inch.

Here is another scale reading down to the ten-thousandths of an inch. But for standard sizes the workman does not use an adjustable tool. He uses a fixed gauge. We have in our works several thousand implements like this [indicating]. This [indicating] is a caliper gauge, male and female. To measure the diameter of a solid piece like this [indicating], we put the gauge over it, so.

Mr. LANNING. Of a solid cylindrical piece?

Mr. TOWNE. Yes, sir. To measure the inside diameter you use this end. These gauges are of hardened steel. The daily use of these gauges involves a little wear. That wear has to be corrected from time to time, and finally the gauge has to be thrown away and replaced by a new one. In order to ascertain how much wear is taking place, we must have a set of "master gauges," which are kept locked up and never used except for reference—perhaps once a year, or once a month, or once a week. These working gauges are carried to the room where the latter are kept and tested by the reference gauges to see if they are worn so much as to be condemned. If they are, they are replaced by others. A working gauge nearly always has to be duplicated by a reference gauge.

Here is a gauge [exhibiting] for certain dimensions on a certain

bank lock. In fact, it covers four dimensions. In this case we have no duplication of gauges—one too long and the other too small—we depend upon the sense of touch of the workman to determine whether the work is of proper size or not, because extreme accuracy is not required. But even with a gauge of this kind the wear is considerable, and therefore we have to have two—one kept in a safe and never used except for reference, and the other for actual use. The working gauges are used by the workmen and from time to time referred back to the standards to see if they are worn.

Here is a sample of a screw gauge [exhibiting], showing that the proper diameter is eighty one-hundredths of an inch, having one hole in which the corresponding male gauge must enter, and another—one one-thousandth of an inch smaller—in which it must not enter. This is a standard or reference gauge, from which are produced the working gauges for the shop. The latter are used, in this particular case, for making such a common article as a metal doorknob.

Mr. LANNING. Can you tell us—perhaps any of us could figure it out, and possibly some of you have done so already—how would eight hundred one-thousandths of an inch be expressed in its metric equivalent, and how would seven hundred and ninety-nine one-thousandths of an inch be expressed?

Mr. TOWNE. The equivalent of a millimeter is 0.0393707904 inch. Now, to convert these existing articles, all of which are dimensioned to the English inch, into dimensions of the metric system, of course, you must go into millimeters. You can not use the meter for such a minute measurement. You have got to multiply each one of your fractional parts of the inch by this string of ten decimals, which is the arithmetical equivalent of the millimeter to the English inch. Now, Mr. Chairman, here is a common and familiar article [exhibiting].

Mr. GAINES. What is that?

Mr. TOWNE. A doorknob, such as the one on the door of this room. It is composed of two parts. The head is made in one piece and the shank for the spindle in another, and these two must be put together. They are united by screwing one into the other, so [indicating]. This is purely a practical question. In our business we are trying to make these things just as economically as we can. The business is intensely competitive, and the people in this country will not pay for frills. Our purpose is to have those two things made so that any two of these pieces, out of a thousand or ten thousand made at different times, shall assemble together properly. We have learned by experience that there is a limit to the variation of dimension which is permissible. We find that limit to be not more than one one-thousandth of an inch in the diameter of the male screw, and not more than one one-thousandth of an inch in the diameter of the female screw. The sum of these errors, if they happen to coincide, would be two one-thousandths of an inch.

Now, to obtain this moderate degree of accuracy, to keep our work within this limit of variation, we have to have gauges, such as you see here. An equipment of gauges for this particular article would probably cost $75 to $100, at least, for one particular size, and we have many of them.

But that is not all. In order to produce repetition work economically, where it involves other mechanical operations, the workman

is not required to use gauges, still less a 2-foot rule. He is furnished with a tool, of which there are many kinds, and of which this is a typical one [exhibiting]. This is called a "jig." This was loaned to me by the Brown & Sharpe Manufacturing Company, of Providence, R. I. The workman puts this jig, containing the work, under a drill press. The jig has two hardened-steel bushings on this end, and the drill is driven through these holes, so that all that the workman has to do is to see that the drill goes into these bushings, whereupon the holes are located in the right places.

The piece of work upon which this jig is used is based upon drawings dimensioned in the English inch and its decimals, next upon gauges, also based upon the same measurements, and is then put into a tool of this kind. Finally, in many cases where great accuracy is required, as in the case of repetition work, it is tested by a gauge, of which I have a sample here, also from the Brown & Sharpe shop [exhibiting]. Every one of these pieces, after it is made in machines of this kind, is put into this test gauge by a workman or inspector, who then holds it up to the light to see that it touches at the testing points; and if it does not it is rejected as imperfect.

It is this vast equipment, Mr. Chairman, of gauges and tools of the most expensive and elaborate character which forms the foundation of American mechanical industries, which enables us to make that product with the economy that we do, and thereby are enabled to sell it in the markets of the world. This equipment would not be obliterated; we have got to keep it for a hundred years yet in order to make repairs to existing machines. But all of it would have to be duplicated with another equipment, of identical character, changed minutely in dimensions, in order to bring it to metric units, if we change to the metric system of measures of length.

Mr. GAINES. Will you tell the committee to what degree you have subdivided the inch?

Mr. TOWNE. In my own business we work ordinarily to the thousandth of an inch, but quite frequently to the ten-thousandth. We have instruments for measuring down to the hundred-thousandth of an inch, and occasionally we have to use them. In the machine tool-building industry the conditions are about similar. In some of our very fine metal industries, such as watch making, the one hundred-thousandth part of an inch is a very sensible dimension.

Mr. GAINES. There is no trouble about subdividing?

Mr. TOWNE. None whatever. And it is pertinent to note that the millimeter, being approximately four one-hundredths of an inch in length, is four times bigger than the hundredth of an inch; and the next subdivision which you can use as a division of the millimeter is four times bigger than the thousandth of an inch. The millimeter is not as convenient a measure in fine work as the inch.

Mr. GAINES. Then it is easier to use what we have than the metric system?

Mr. TOWNE. Yes. With all the manifest advantages of the metric system in some respects, which we engineers frankly concede and admire, we also know, and many engineers in metric countries concede the fact, that the meter was an unfortunate unit to adopt for the system of measures of length. The meter is too long, even for large work, and the millimeter is equally too long for fine work. The

English foot is a better unit for dimensions of an ordinary size, and the English inch vastly better for fine measurements.

Mr. GAINES. How long have you been in this business?

Mr. TOWNE. Thirty-five years. The business of making gauges is a large industry. Here is a catalogue[a] of the Brown & Sharpe Manufacturing Company, of Providence, R. I., and also a catalogue[a] of the Pratt & Whitney Company, of Hartford, Conn., both of them filled with tables of dimensions and with price lists of gauges and scales of length. Ninety per cent of them are based on the English inch.

Now, gentlemen, here are blueprints which the Brown & Sharpe Company kindly loaned me, to show how these gauges are produced. Look at the mass of figures on this [holding up a blueprint]. Every one of them is in the English inch and its decimals.

Here is a blueprint [exhibiting] of a gauge to measure automatic car couplers of the Master Car Builders' standard, used throughout the United States. The Westinghouse Company will show you the similar gauges made to test the standard car couplers for air hose. Other manufacturers will show you similar gauges for couplers for steam hose for cars. All these things are being standardized. They are not fully standardized yet. The couplers of freight cars are not yet completely standardized, but they are nearly so.

The existence of a standard, Mr. Chairman, requires some method of maintaining it. You must have a master model or an accepted gauge—a record to go back to and refer to, which you preserve, as the standard foot is recorded and preserved in the Smithsonian Institution in this city. Somebody must keep that standard, and from it must be reproduced the working gauges which go out to the thousands of mechanics all over the country, with which they can measure work as they produce it, and the devices used to determine when a piece of mechanism is perfect, and fit to go into use, and to determine when an article already in use has become so worn or disfigured as no longer to conform to the standard, and no longer will interchange with other similar pieces.

Thus, Mr. Chairman, I could talk for a week, and skim merely the surface of this subject, so vast are the ramifications of the efforts made in this field by American manufacturers. But what for? To preserve our standards.

Now, you are asking us to wipe out these standards and throw them away. And what for? Where is the compensating benefit to come from? Who is to pay this frightful bill of expense? American manufacturers would be ruined by it. Who else wants to foot the bill for them? They are not asking for this change. It is open to anyone to work with the metric system to-day if he wants to. It has been legal since 1866. A few have availed themselves of it in certain limited directions. Mr. William Sellers, of Philadelphia, who was here last week, has used the metric system for thirty-five years in one department, and has good reasons for doing so; but that is only in one part of his great establishment. In all the rest of his establishment—80 or 90 per cent of it—he is using the English inch, and would as soon think of stopping his business entirely as to intro-

[a] Filed with the committee.

duce the metric system in the other 80 or 90 per cent of his establishment.

Mr. GAINES. Whether the use of the metric system is to be compulsory or not, according to this bill the Government will proceed to the use of the metric system. Would not that be practically compulsory upon people who execute Government contracts?

Mr. TOWNE. It would.

Mr. GAINES. And to what extent would that reach down to the manufacturers and the people of the country, and compel them also to get the measurements and adopt the metric system in their business?

Mr. TOWNE. It would compel all who undertook Government work to adopt the metric system in their tools and gauges for Government work, and yet to maintain their present equipment of tools and gauges for use in all their other business, or else it would compel them to decline to bid on Government work. Take my own company, for example. About 2½ per cent of our annual business is done with Departments of the United States Government. If we were required to substitute metric sizes for our standard sizes, the game would not be worth the candle. We would simply withdraw from Government business. The products which the Government buys from us are commercial products. We simply sell to the Government part of our regular commercial output. We do not make anything especially for the Government.

Mr. DRESSER. You make regular stock goods?

Mr. TOWNE. Yes, sir.

Mr. GAINES. You say you would refuse to do such work, and that would force the Government to compel manufacturers to establish the manufactures on the metric system, would it not?

Mr. TOWNE. Not in my own opinion.

Mr. GAINES. If the manufacturers on the outside would not do it, how could we get our work done?

Mr. TOWNE. The Government, or Congress for the Government, would change the law.

Mr. CANDLER. Would not the manufacturer in quoting prices or in making bids to the Government take into his account the additional expense in doing the work, and in the end would not the Government be paying the expense?

Mr. TOWNE. Yes, sir.

Mr. GAINES. Mr. Westinghouse said that very thing could be done, and that the cost of the change would have to be paid for by the Government.

Mr. TOWNE. Directly or indirectly it would.

Mr. DRESSER. It would add to the price of the product?

Mr. TOWNE. Yes, sir; Government work is a very slight percentage of the total work of the country.

Mr. CANDLER. Would not the further result be that the manufacturers who made those contracts with the Government and made those changes in order to do Government work continue to do that work in the future when other manufacturers would refuse, and would there be any probability after the introduction of the system that they would reduce the price?

Mr. TOWNE. I think not, sir.

This question does not end with the workshop. Back of the workshop lies the engineer. Here is a little handbook, Kent's Hand Book of Engineering, one of many books of the kind. The type is as fine as the type of a Bible. It is on thin paper. It is an engineer's bible, filled with formulæ and rules regarding engineering practice. All of these formulæ, which start with the theory of mechanics and engineering, and have necessarily to include the element of workshop practice, are based on the English foot and the English inch, and also, when they relate to steam engineering and stresses, on the English pound. The American and English engineer thinks in his own units, the foot or inch and the pound.

Mr. LANNING. Give us the title of that book, so that it may go into the record.

Mr. TOWNE. Kent's Engineer's Pocket Book. It contains 1,075 pages.

Mr. DRESSER. That is 18 karats fine. [Laughter.]

Mr. TOWNE. Now, Mr. Chairman, a change in measures of length and weight would compel the American engineer to learn a new language, to think new thoughts. This generation can not do it. Posably another one could begin to. But we are still living in our own generation. How are we American manufacturers to maintain the fight with our competitors all over the world? The question at issue is so vast that in the limited time you can afford me here I can only touch its surface at a few points.

I want to go back for a moment to the export question and discuss this fact: The best market for high-class products in the world is the English market, because there is more capital there and a larger wealthy class of buyers there than anywhere else. England is one of the best markets for American manufactures. The markets of England, Canada, and the English colonies constitute a very large fraction—nearly 50 per cent—of the foreign market for American manufactures. These markets use the English inch, and so far as measures of length enter into commercial transactions they want the existing standard continued. They do not want the metric standard. In adopting the metric standard American manufacturers would handicap themselves to that extent in all their transactions with the English-speaking part of the world.

Mr. GAINES. But England is threatening to adopt the metric system.

Mr. TOWNE. The English scientists are; not the common people.

Mr. GAINES. But some of their lords over there are?

Mr. TOWNE. Yes; beginning with Lord Kelvin.

Mr. GAINES. What do you know about that?

Mr. TOWNE. What I can glean from a considerable reading in English journals, and I see clearly this fact, that the advocates of the measure, who are perfectly sincere and earnest, are chiefly scientists and theorists, and that the practical men of affairs, who manage English mechanical industries—and many of them are titled men, if that counts for anything—are three-fourths of them opposed to it.

Mr. GAINES. Yes; I added that up last week with one of the witnesses here who had a long list of the House of Lords and others. We had it in a printed report, and I find when you subtract that number from the total number in the House of Lords and in the

House of Commons the advocates of the system are away in the minority—that is, the majority are opposed to any change.

Mr. TOWNE. Yes; and if a census were to be taken of English manufacturers on the subject I venture confidently to assert that not 10 per cent—I doubt if 5 per cent—would favor the change. If you should take a poll of the House of Representatives on this question probably a majority, offhand, would be in favor of the metric system on theoretical grounds, because they have read enough about it to know its manifest advantages and to know that our American system needs some revision. But take a poll of American manufacturers and you would not find 10 or even 5 per cent who would favor the metric system. This question should not be closed until such a poll of American manufacturers has been taken.

Mr. CANDLER. Do you know of any demand on the part of people engaged in practical business in this country who are asking or demanding this change?

Mr. TOWNE. Not one. Why should they ask for it? It is open to them to-day to use the metric system.

Mr. CANDLER. Is it not a fact that the demand for it comes entirely from scientists and theorists in this country as well as in England, while the practical manufacturers are all opposed to it?

Mr. TOWNE. Yes; the scientists and theorists, in the goodness of their hearts, seem to think they know better what is good for us in our own business than we know for ourselves.

Mr. CANDLER. You spoke of the agricultural interests of the country. By what weights and measures are the agricultural interests and business between this country and foreign countries carried on?

Mr. TOWNE. By both systems—part metric and part English. In South American countries they have various systems of weights and measures, but there is no more difficulty there in that respect than in financial dealings. You must simply know the rate of exchange. That is all.

Mr. GAINES. We had an examination into the standard systems, away back yonder in the early days of the Republic, by John Quincy Adams, who worked at it, I think, four years, and then made a report. I have never read the report.

Mr. TOWNE. It is an admirable one.

Mr. GAINES. I wanted the committee to print it, but it would cost so much money it would bankrupt the Government. As I understand, John Quincy Adams said the metric system was a beautiful theory, but at that time it was not a practical system, and he thought we had better not adopt it, and we did not. But it was an effort to get a uniformity. Now, I ask you if to-day we are not at a uniform standard sufficient to supply all the business in this country, and to accept all our business, and no one is complaining?

Mr. TOWNE. Exactly; and above all, in measures of length.

And now, Mr. Chairman, I will close with this final argument: What shall be done with this question? If the committee cares for my opinion, it is this: The subject is a most important one. It is a proper one for the Government to deal with, and unquestionably there is room for some improvement in our present standards of weights and measures, but it is supremely a practical and technical question. In France it was dealt with by scientific commissions, one

after another. In Germany it was dealt with by a large technical commission. In both cases eleven years were required by those commissions to do their work.

What I hope your committee may decide to do is to draft a report recommending, and to introduce a bill for the creation of, a national commission on standard measures of length, weight, and volume, and providing for the appointment on that commission of leading scientists, leading engineers, leading manufacturers, men versed in all of the various phases of this question, and they are many. The commission so appointed should be authorized to make a report, when ready, as to what, in the light of all the evidence it can collect, is the most expedient thing to be done with our national standards.

Mr. GAINES. Why should we do anything, if everybody is satisfied?

Mr. TOWNE. There are some of our measures which could be improved. I think our three measures of weight could be unified into one with no disturbance. I think our measures of volume could be united into one and harmonized with the English system. Measures of weight and of volume relate practically to the present and the future. They have little to do with the past. But measures of length, gentlemen, in the language of one of the persons who has written on this subject "are linked irrevocably to the past." You can not obliterate them. You may compel manufacturers to submit to confusion, where we now have uniformity, and to incur an enormous expense in duplicating their standards of length; but you can not obliterate the existing system. "It is linked irrevocably to the past."

Mr. GAINES. I used to be a farmer. Your suggestion now is to change some of the measures the farmers use in the country, in the towns, and in the cities. I used to sell by the quart and peck, and with a gallon measure, and I never had any trouble in measuring.

Mr. CANDLER. Did you sell by the gallon, did you say?

Mr. GAINES. In the towns they would want to heap up. But I quit farming and came to Congress, and am not doing much better than I did before.

STATEMENT OF MR. JAMES C. HOBART, ELECTRICAL MANUFACTURER OF CINCINNATI, OHIO, REPRESENTING, IN CONNECTION WITH MR. WILLIAM LODGE, THE MANUFACTURERS' CLUB OF CINCINNATI; ALSO A MEMBER OF THE NATIONAL ASSOCIATION OF MANUFACTURERS.

Mr. HOBART. Mr. Chairman and gentlemen, I am not a speaker, so that when I have anything to say I do not talk it, but I write it; and in order to save your time here as well as my own I think I will confine myself pretty strictly to what I have written.

I can present what I have here, I think, in about ten minutes. I do not know that I can bring forward any new facts for your consideration; but if I can clothe old facts in a new garb, so as to impress you with the burden this measure will lay on the manufacturers, I shall have accomplished what I desire.

In the first place, the adoption of the metric system in all the departments of the Government means that sooner or later it must be adopted by the public.

The Government is by far the largest single purchaser in this

country. If it demands materials, supplies, and equipment made under metric standards, that demand must sooner or later be supplied by the manufacturers of the country.

Many manufacturers would undoubtedly decline to bid on metric specifications, but while such course would delay the general introduction of the system it could not ultimately prevent it.

The manufacturer filling a Government order under metric specifications would desire to purchase his supplies, the necessary special tools, etc., required to complete his contract from other manufacturers, which in turn would compel them to adopt metric units.

The ramifications of an order for a single electric equipment would reach probably a hundred different concerns.

Every manufacturer who once accepts an order for a machine built under metric units must ever after carry a double investment, in the necessary patterns, jigs, stock of materials, and parts to enable him to supply, repair, and duplicate parts, both for the apparatus he has previously put on the market under English standards and for whatever he turns out under metric standards.

This for the reason that it is absolutely impossible to transfer from one system to the other by simply altering English dimensions to the equivalent metric dimension and retain necessary accuracy.

For instance, take the dimension $2\frac{5}{16}$, a common one for shafting. Now if that dimension were converted into metric measure it would be 7.461264+ centimeters. In other words, it does not come on any even division of the metric scale and this must necessarily be true of every dimension that is not some multiple of 3937.

I might, in passing, just call your attention to one thing particularly, and that is the difference between the exact dimensions, $2\frac{5}{16}$ of an inch, transferred to the metric system and carried to the fourth place of decimals, which, as you have heard, is practically what all machine shops do. That would make a difference of two and a fraction ten-thousandths of an inch. You have heard that the manufacturers of to-day are working up to one one-thousandth, and sometimes to one one hundred thousandth of an inch.

It would therefore be absolutely impossible for any manufacturer to retain present patterns, jigs, and dies. He must necessarily make new drawings and a complete new equipment of such items in order to produce under the metric system on the same basis he is to-day producing on the English.

To one who has not actual experience in American machine-shop methods it is difficult to convey any adequate idea of the confusion and loss the introduction of this system would entail upon the manufacturers.

Under wise legislation this Government has encouraged and developed its manufacturers to an enormous extent.

To-day we are sending our manufactured product to every country on the globe, whether that country has adopted the metric system or not, in the face of competition which pays lower wages and gets its raw materials cheaper than we do.

How has this result been accomplished? Why, if the metric system is so far superior to the English, are we able to go into metric-system countries and compete with home production with labor cost and material cost against us in addition?

Because, gentlemen, the American manufacturer has reduced manufacturing to a science.

By an immense investment in metal patterns, metal jigs, and special tools he is enabled to turn out many more times the product in a given time than can his competitors.

Moreover he has thereby achieved an accuracy that can be secured in no other way. And here is the point, gentlemen: Every purchaser of an American machine, whether he be in China or South Africa, in Russia or Argentine Republic, knows that he can get from the maker any part of that machine any number of years hence, and that it will be an exact fit; that he can place the new part in the old machine and it will work.

It is this reputation earned at vast expense which, as much as any other one thing, is responsible for the ascendency of American manufacturers over all others.

And it is this, gentlemen, which with one stroke of the pen you propose to wipe out. The results of years of ingenuity and toil, of millions of dollars of investment, this bill proposes to give away without the slightest compensation.

If this bill becomes a law, the manufacturers are placed practically where they were fifty years ago, when they built machinery to order before manufacturing was reduced to the science it is to-day, when articles of manufacture that are to-day considered among the necessities of human existence were beyond the reach of all but the wealthy.

In fact, they are in a worse position inasmuch as they will now be loaded with a duplicate equipment. The equipment they now have, which must be retained to supply repairs and duplicate orders and the equipment they will have to get to manufacture under the metric system on a basis that will permit them to compete in foreign markets.

Until manufacturers do place themselves on such a basis this Government and the people must pay the higher cost which will be the result of manufacturing to order instead of in quantity.

This country surpasses all others in the extent to which it has specialized its manufacturers, and as stated above this is one of the greatest reasons for the wonderful growth of its manufacturing interests.

Specializing has secured for the manufacturer such an increased output for man as has enabled him to pay higher daily wages than anywhere else and still compete.

Mr. GAINES. How much more can the American workman turn out per day than the foreign?

Mr. TOWNE. Perhaps but a small fraction more than his competitor if all other things were equal; but supplied as he is with tools which the American manufacturers give to the American workman to work with, he turns out many times more than his foreign competitor.

Mr. GAINES. Can you approximate that?

Mr. HOBART. That could in part be derived from an approximation of the higher rate of wages paid here than abroad.

This specialization has, however, been secured only by the introduction of a very expensive equipment—metal patterns that insure one casting being the same as the next forever—metal gauges, jigs, templates, punches, and dies accurate to within the ten-thousandth

part of an inch, all of which enable the duplication of any piece a century hence.

This equipment devoted solely to the purpose of securing accuracy and low cost of production varies from 20 to 33⅓ per cent of the entire machinery inventory of a factory. In other words, a comparatively small factory with a machinery and pattern inventory of $100,000 would have to replace at least $20,000 worth of that class of equipment if this bill becomes a law.

The cost to the manufacturers of this country in this item alone would run into the billions.

To my mind it is difficult to conceive where this committee can expect this measure to show results which would fractionally reimburse the country for this immense loss.

There is no more need of a universal system of weights and measures than for a universal coinage or language, and of the three the change in the last two together would result in less loss and confusion than an attempt to change our standards of measures.

There is no necessity for the change; the inch decimally divided gives us as good a system as the meter. The demands of the trade have developed this.

Other trades, if they find it to their advantage, can decimally divide our other units without the necessity of changing any standards.

I would like to quote generally from the paper prepared in 1898 by Mr. H. M. Lane, president of the Lane and Bodley Company, of Cincinnati, Ohio, engine builders. I would like to quote simply from two pages; and there is one thing particularly that Mr. Lane very aptly puts in his remarks as to the advocates and opponents of the introduction of the metric system in this country when he said:

The pro and con in this case seem to be represented—the pro by the professor and the con be the con-structor.

He says, on pages 8 and 9 of his address, which was delivered before the Manufacturers' Club of Cincinnati on May 9, 1898:

But why should we change? What is the matter with our weights and measures? Oh, they are not scientifically derived; they originated in the length of grains of barleycorn, the length of a dead monarch's foot, or of King John's right arm, or, later, the length of the pendulum beating seconds. The latter, scientific enough in conception and, like the quadrant measurement, impossible of reproduction; but they got there just the same. That is, the two lines got on a metal rod a certain distance apart and is called a yard, just as two other lines got on another metal rod just a little farther apart and is called a meter. This is absolutely all there is in either standard—two lines on a stick—one just as good as but no better than the other, and both standards because they are called standards and for no other reason whatever. When we have reached this fact, all of the literature relating to derivation of standards becomes of no importance, and we may seriously ask why we should abandon our unscientifically graduated stick for their unscientifically graduated stick? Why should the Anglo-Saxon mountain of millions in interest involved go to the Mohamet of Latin thousands? Why should Great Britain and her colonies all over the world, and the United States, including Alaska, the Sandwich and Philippine Islands, Cuba, and Porto Rico, drop their own stick as though there was something wrong with it and take up the stick of the Dons?

Our foreign transactions are carried on very successfully in tons and feet and inches. Only last week a certain transaction at Manila, by ships of so many tons burden, carrying guns of so many inches caliber, and throwing shot and shell of so many pounds weight, proved their immense superiority over those constructed, armed, and throwing projectiles of metric dimensions and weights. The only possible reason for us to change would be that of securing the advan-

tage of uniformity, but with the English-speaking people of the world united in the use of the yard, would we not be losing rather than gaining in this respect?

Another reason urged for the adoption of the metric system is that it is a decimal system, but the opponents charge that for most purposes this is its greatest defect. Divisions by tens is not a natural one; it arose from the primitive habit of reckoning by the fingers and thumbs. If we had had one more of each on each hand, we would have had twelve for the base, a much more convenient number, being divisible by six, four, three, and two, all of which dimensions are useful. It may be halved and quartered, while ten has but two factors, two and five, the latter being useless. The use of the decimal system does not necessitate the use of the metric system, for what civil engineer in Cincinnati uses anything but feet and hundredths of a foot, and what machine shop does not use inches and hundredths and thousandths of an inch? We are as free to use decimal divisions of our measures as the metricists, and can, in addition, divide our inch into halves, and again into quarters, then eighths, sixteenths thirty-seconds, and sixty-fourths, all natural and convenient divisions and subdivisions, by halving. We started with the decimal system with our currency, but what are our small coin—subdivisions of the dollar—to-day? Half, quarter, tenth, and twentieth—only one out of four decimals. The hours of the day, months of the year, divisions of the circle, astronomical, and nautical measurements are not adapted for decimal subdivisions.

After reading considerably on this subject, the mind is apt to be in the condition of a juryman's after the lawyers for both sides have finished their arguments. The mind remains clear upon one point only, viz, that there is so much for and against the change that no hasty action should be taken.

In conclusion I would suggest that this club instruct its Congressmen to oppose any change except by agreement to change at the same time and to the same system of all the English-speaking people on the face of the earth.

Mr. GAINES. Have you that uniformity under our present system that is necessary to enable us to perform these wonderful feats?

Mr. HOBART. Yes, sir. Under the present English system we have. I have just two or three short letters here that have been handed me, which I would like to submit. Here is the authority of the Manufacturers' Club of Cincinnati for me to represent them here, and here are the resolutions of the Manufacturers' Club opposing the adoption of the metric system by the Federal Government. And here is a letter from the Lane & Bodley Company, addressed to your committee, but handed to me for delivery. And here is also a letter from the Houston, Stanwood & Gamble Company, of Cincinnati, engine builders, telling about their immense investments, and especially bringing out the point that to-day they are furnishing the repair parts of engines which they built twenty-five years ago, and showing how impossible it would be for them to furnish those parts if they did not retain the gauges and templets and patterns from which those parts were made.

And here, gentlemen, is another letter, from the Bullock Electric Manufacturing Company, of Cincinnati, showing that it would cost $300,000 to replace their present investment in drawings, gauges, patterns, and tools. All of these papers I would like to go in the record.

Mr. LANNING. Very well.

MANUFACTURERS' CLUB OF CINCINNATI, OHIO.
Cincinnati, February 9, 1904.

Messrs. J. C. HOBART, WM. LODGE.

GENTLEMEN: I beg to advise you that at a meeting of the Manufacturers' Club held on February 8 you were appointed a committee to represent the Manufacturers' Club before the Congressional committee having in charge the metric-system bill.

Yours, very truly, E. P. WILSON, *Secretary.*

Resolutions adopted by the Manufacturers' Club at its meeting held at the Queen City Club, February 8, 1904.

Whereas a bill for the adoption of the metric system in the departments of the Federal Government is now before the Committee on Coinage, Weights, and Measures of the House of Representatives;

Whereas such a bill can have but one of two results—the creation of a special system of Government weights and measures on the one hand or a change in the system used in the commerce and industries of the country on the other;

Whereas a special Government system of weights and measures would be as absurd as a special Government system of currency; and

Whereas a change in the weights and measures used by the people at large can only be accomplished at great cost, after generations of confusion and with no adequate compensating advantages: Therefore, be it

Resolved by the Manufacturers' Club of Cincinnati, That we condemn this bill as wholly mischievous in its tendencies.

Resolved, That we condemn all legislation intended to bring about the adoption of the metric system in this country.

THE LANE & BODLEY CO.,
Cincinnati, Ohio, February 8, 1904.

The COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
Washington, D. C.

GENTLEMEN: We respectfully, but most urgently, protest against the introduction of the metric system.

It would impose an enormous burden upon machine manufacturers and iron workers of this country. If we could change from the English to the metric measurements as a man changes his coat, we would offer no serious opposition, but we can not put one off and put another on like a coat, but throughout the burden and heat of the day must wear them both.

Our concern has been in operation about sixty-five years. We have machinery in perhaps every civilized and many of the uncivilized countries of the earth.

For renewals and repairs during the life of this machinery, some of which is in excess of fifty years, we must maintain our old drawings and patterns, gauges, jigs, templates, drills, taps, dies, reamers, and rolled, hot or cold, bars suitable for shafts of the old sizes, together with stocks of screws, bolts, pipes, nipples, couplings, elbows, and other pipe fittings according to the present system of measurements. All these must be retained and maintained, in addition to duplicates of each tool and article of metric dimensions, if this new and undesired system is forced upon us.

We protest against the imposition of this system, because it is unfair, unnecessary, and uncalled for by those most interested.

We inclose a pamphlet which expresses the views held by the writer in 1898.

Yours, truly,

THE LANE & BODLEY CO.,
H. M. LANE, *President.*

THE HOUSTON, STANWOOD & GAMBLE CO.,
Cincinnati, February 10, 1904.

Mr. J. C. HOBART, *City.*

DEAR SIR: You asked my opinion relative to the adoption of the metric system in the manufacturing establishments of this country. Will say in response that since you raised this question I have looked at our books and find of the total amount that we have charged on our books to the tool and equipment account about 12 per cent is in gigs and tools such as would become obsolete if a new system of measurement were adopted. In businesses like that of machine tools, brass and iron pipe fittings, and brass goods we think at least 25 per cent of the total tool and equipment account would become obsolete. This, however, in my opinion, is not the greatest objection in a business like ours. We are to-day sending out parts for repairs on engines that we shipped

twelve years since. When an order for a repair piece comes in, we go to the shelf where the parts for engines of that size are kept and ship the piece without a question whether or not it will fit. It always fits.

Now, previous to the time the writer has been connected with our present business he spent about twenty-five years with another manufacturing establishment. It was a frequent occurrence to send pieces for a machine that had been out twenty-five years, and there was but little question whether or not the piece would fit because it had been made standard. Especially within the last twenty years has the standard for screws become so general that this very troublesome problem seemed to be settled. Now, if we were to change to another system of measurement it would be necessary to maintain a set of tools for a great many years by which to make these parts for repairs, and it would also require a great deal of attention, and in spite of the best that could be done many blunders and much expense would be caused by substituting one system of measurement for the other. We have heard the argument advanced relative to producing an equivalent in the metric measurement to the measurement we are using at the present time. The writer is of the opinion that this is not practical and would cause much confusion. Much might be said about the relative value of the two systems of measurements and their convenience, but we prefer to consider it only from the standpoint of where we have had most experience, namely, in the shop.

Yours, respectfully,

C. R. HOUSTON,
Vice-President and General Manager.

STATEMENT OF MR. WM. LODGE, PRESIDENT OF THE LODGE & SHIPLEY MACHINE TOOL COMPANY, OF CINCINNATI, OHIO.

Mr. LODGE. If you will permit me, gentlemen, to say a few words, I will not keep you more than five minutes. What I will say shall be entirely oral, and will lack the scholarly presentation of my friend, Mr. Towne, but it will be quite practical, as I think you will see as I go along.

Mr. GAINES. Where are you from, sir?

Mr. LODGE. From Cincinnati. I am president of the Lodge & Shipley Machine Tool Company, and also a member of the National Machine Tool Builders of America. I have in my hand a photograph of the distributing department of our small-tool works [indicating]. You will notice that it is composed of 5 shelves. There are 12 of these stands, which are double—one on each side. That one line of gauges similar to this represents an expenditure of $500. There are 12 stands. Ours is but a small business and this represents merely the manufacture of lathes, which is only one machine in the machine-tool business, which is composed of perhaps 200 or 300 different machines.

I asked the question of Mr. Towne a short time ago as to the question of equivalents, he having stated that one of the shelves represents $500. I asked Mr. Towne the question as to how many he thought he had on his shelves, whether he did not have $10,000 worth on them, and he said he had many times $10,000 worth; and, further, that not one of these thousands of dollars' worth of gauges could be made into equivalents of the metric system, not one. There is no equivalent. Consequently they must stand only as representing the English inch and its modifications.

Referring to the question you asked Mr. Hobart, about the difference between the output of the American mechanics and the English and others, I would remark that I served my time in England as a mechanic. Thirty-five years ago I emigrated to this country and became an American citizen. Thirty years ago I began business,

with a capital of $1,000; and along in 1886 I had occasion to pay a visit to England, simply on a vacation.

While there I called upon a machine-tool builder, a former acquaintance, and while we were talking I pointed to one of his machines and said: "What price do you get for that?" He said, "£145." I said, "You get a good price." He said, "Yes; but you could not build that in America for such money." I said, "No; we could build a better one than that for less money." He said, "That is nonsense; you pay more for labor than we do." I said, "Yes; we pay double what you do." He said, "Your fuel costs you as much and your power costs you so much; how is it possible for you to produce it?" "Well," I said, "that may be, but I am willing to enter your order for $100,000 worth of these machines, and guarantee them to be better than this one you have here, and deliver them in Liverpool for 10 per cent less than your price; and I will give bond for the fulfillment of the contract." He said, "Will you tell me how it is possible for you to do that?" I said, "It is rather a big question;" but I added, "Do you see this man over here?" [pointing to one of his workmen] and he said, "Yes." The workman was engaged with numerous devices and rules and calipers, marking different spaces. I said "That man has been engaged on that work, I should think, at least five hours, and I should think it would take him five hours more." The manufacturer said, "Yes; about that." I said, "He is a skilled man and a high-priced man?" He said, "Yes." I said, "We will do that same work with an unskilled man in one hour, and it will be a much better piece of work."

After a bit he said, "Oh, I begin to see where the difference is. But how do you do it?" I said, "We simply make a templet"—just such a one as Mr. Towne has been illustrating by showing our standards and measures and getting every hole alike and where it should be—"and shut it up, give it to an unskilled man, and put into the machine." He said, "I am very glad to know that that is so."

At the same time that I commenced business a friend of mine started a little shop in the back kitchen of his residence. He had the same idea—the manufacturing idea—and to-day he is president of a company whose output is close upon a million dollars every year, and goes all over the whole world.

Some time ago Russia shut out the American tool. If she had let it come in perhaps she would have had a little better success in her recent operations near Korea. [Laughter.]

The mere fact of the American manufacturer giving his attention to the standardizing of his products and making it possible for him to ship it anywhere in the world and send duplicates of it or parts of it should of itself be a sufficient argument to gentlemen handling this question not to upset all of this and put such men as ours out of business.

I am free to say that if the Government offered me a contract of $10,000, with a stipulation that the product should be completed on the measures of the metric system, I should refuse it instantly.

Mr. GAINES. Why?

Mr. LODGE. Because I could not afford to touch it. I have got no metric measurements. We have no equivalents for it. In order to make that product it would cost something like eleven times more

than I would get in money for the order, in order to place myself in position afterwards to duplicate the order, or a similar order.

Mr. GAINES. Suppose the Government paid you what it cost you to make the change, then would you do it?

Mr. LODGE. Then I should consider it a little more carefully. [Laughter.]

Mr. GAINES. If the Government would make a continuous contract with you as long as you are in business, you could furnish this material to the Government of the United States and go to the trouble of equipping your machines with the metric measures?

Mr. LODGE. Yes, sir.

Mr. GAINES. But if it were one job only, you could not afford to do it?

Mr. LODGE. No; I could not afford to do it. I am much obliged to you gentlemen for your attention.

Mr. GAINES. How much more work per day can the American man produce, as he now works, than the Englishman can produce as he now works?

Mr. DRESSER. Using the standards as they use them now.

Mr. LODGE. I am not so well acquainted with the English products.

Mr. GAINES. I mean as to your observation.

Mr. LODGE. Well, they were building their machines without templets. If they were building without them and we had them and used them the difference would perhaps be—it would cost them at least four times more than it would cost us.

Mr. GAINES. In other words, we would make four times more per man or machine than they would?

Mr. LODGE. Yes, sir.

Mr. DRESSER. And it would be more accurate work?

Mr. LODGE. Yes, sir.

Mr. GAINES. He [Mr. Lodge] clearly stated that this man had been working five hours, and it would take five hours more to finish that work, and with his system, Mr. Lodge's system, he could do it in one-tenth of the time—that is, in one hour.

Mr. TOWNE. If you will allow me to supplement what Mr. Lodge said—I can do it in two minutes.

Mr. GAINES. In other words, it would take ten times as long to do it or as much to pay for it.

Mr. CANDLER. He said, taking all of that into consideration, it would make four times as much.

Mr. TOWNE. Here is a jig [exhibiting] full of holes. The unskilled workman or the boy takes that and puts it into the drill press and runs his pattern into it, and, behold, it is done. To do that as Mr. Lodge's English friend would do it, that piece of work has got to be put into a vise and held by a fine gauge and marked by the marker carefully and the measurements or marks indicated with a punch before he is able to go on with the drill; and that involves a degree of intelligence and skill that requires a high-grade workman; whereas we give an unskilled workman a thing of this kind made by a high-priced man and an unskilled man or a boy does the work with it.

Mr. GAINES. Now, tell us how much more an American man can produce in your business, with your machinery, than the Englishman produces with like machines.

Mr. TOWNE. Let me put it this way rather: That, given a proper equipment of special tools and gauges, such as we have described here to-day, an unskilled workman will do more in one day than a skilled workman without that equipment would do in three days.

Mr. GAINES. In other words, then, the output is nearly three times greater?

Mr. TOWNE. Yes; and with much cheaper labor. We can utilize unskilled labor for very important operations, where they employ only skilled labor. We exempt our skilled labor from such drudgery and employ it on more congenial and suitable work.

Mr. DRESSER. And it is more accurate.

Mr. TOWNE. Yes, sir.

Mr. CANDLER. How long does the gauge last?

Mr. TOWNE. The reference gauge does not wear out at all, and the working gauges depend upon how they are used as to whether they will wear rapidly or slowly.

Mr. COLLES. Is not this a fact, that after the skilled workman has gone over and prepared this work it would not be accurate enough for American work?

Mr. TOWNE. Yes; with unskilled labor we produce more economically and a much higher grade of work than they produce with their skilled labor.

Mr. HOBART. This jig—I do not know about this particular one—but a jig of this character will frequently cost about five times the price of the first piece that is turned out with it. Some of them will run 500 times as much. You can readily see, when you have a large diversity of output, how much you have got invested in those things.

[Memorandum filed by Mr. Lodge.]

OBJECTIONS TO THE METRIC SYSTEM.

The changing over from the English system to the metric system in the machine-tool business is quite a different proposition than in many other kinds of businesses. The work which is carried through in such establishments is generally large in quantity and with the most refined precision.

In order to make the machine parts interchangeable they are manufactured in a similar manner as small firearms, which most of us are more or less familiar with. We can take a piece out of one gun and replace it by another, and which is made perfectly without the slightest fitting. The present method of manufacturing is such that a manufacturer of machine tools can not depend on the skill of the workman in making these parts. The work is accomplished by a system of especially designed fixtures, commonly called jigs, for most every operation on the various parts of the machines, and the success of a business of this kind largely depends on how ingenious these jigs or fixtures are designed and made.

From our experience we know that after a machine tool is designed such fixtures to facilitate the manufacturing operations of same cost eleven times more than the machine itself. That is to say, if a machine is made to sell for $500 the fixtures made to facilitate the manufacturing of same will cost eleven times $500, equaling $5,500.

Take, for example, the Cincinnati Milling Machine Company, who make fourteen different sizes of machines, and according to the above figures these fixtures will aggregate a cost of $77,000. These fixtures can not be bought in the open market. Every concern is then obliged to build these fixtures to suit their own requirements and do their own experimenting to make them work properly.

At the present time these jigs are all made in English measurements, and if the metric system becomes compulsory most of these jigs will have to be built over or thrown in the scrap. Some may believe that all that will be necessary to bring about this change in measurements is simply to convert the present

English measurements into the metric measurements. This, however, can not be done, because the product would first have to be redesigned and the standard metric measurements employed. After that the tools and jigs would have to be made to produce the article in accordance with the new measurements. In some cases it will require an entire reconstruction of a machine, because some spaces in the machine are so limited, said alteration being necessary if the metric system is used. While speaking of gears, it will also be necessary to change all the gear wheels entering the machine, because the teeth of same would have to be made to conform to the metric measurements and which would mean a change in the present diameters, which in turn would necessitate, in many instances, a radical change in the design of the machine. This gear question alone would result in a loss of thousands upon thousands of dollars in this country.

Referring to the fixture question again, I would say that it would take years of very ambitious hard work to reach the same result that we are employing to-day, notwithstanding, however, that we would be obliged to drag along with both systems for years to come, since thousands of machines in operation to-day would have to be supplied with new parts from time to time.

When Germany adopted the metric system, somewhat over thirty years ago, it was a blessing to the manufacturers, because they were then employing various systems of measurements, and it was a good move at that time to come to some uniformity, but the problem confronting us here is quite different. We are a great manufacturing nation, equipped with the most exacting refinements and special facilities adapted to the manufacture of our goods, and which is the only secret which enables us to compete with the world at large.

If we are compelled to change these jigs to the new measurements, it would cripple us for years and result in a loss of untold millions of dollars.

FRED HOLZ,
President Cincinnati Milling Machine Company, Cincinnati, Ohio.

STATEMENT OF MR. GEORGE WETMORE COLLES, OF MILWAUKEE, WIS., CONSULTING MECHANICAL AND ELECTRICAL ENGINEER AND MEMBER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Mr. LANNING. How much time would you like?

Mr. COLLES. About ten or fifteen minutes, I think. I am here by invitation of Mr. Gaines, and also of the chairman and of Mr. Shafroth.

Mr. Chairman and gentlemen, you hear a great many arguments during the hearings, not only in this series, but also last year and the previous year, for and against the metric system. Some of the men who have appeared before you have said that it is a good thing and ought to be pushed along. Others say it is inferior to our existing system.

It is not my intention, in these few remarks that I have to make, to take up your time with arguments as to the superiority of the system. I regard the question of the superiority of one system over another as purely an academic question in the present condition of affairs. I understand that we are considering not a system, but a bill, and that bill is for a certain step for promoting the metric system. The discussion of the comparative merits of the system, I believe, has never been settled satisfactorily, one way or the other, and probably never will be, and such a discussion tends to becloud the main question altogether, which is alone that of feasibility.

Now, I do not believe that any of the gentlemen who are pushing this matter forward can have any adequate conception of the task they have in hand. If they mean that our country shall ultimately come to use the metric system in place of the existing English weights

and measures in general, ordinary life—if they mean nothing else than that, then they certainly mean a confusion of measures. Now we have substantial uniformity.

The difficulty, however, has been well shown by experience in the passage of laws by the various countries abroad, particularly by France and Germany, and others. It is an unquestioned fact that those countries have passed laws imposing the metric system again and again, and repeatedly; and still, after scores of years, the metric system is not yet in exclusive use there, but far from being so. The common people in the main have not adopted it in all of those countries, but still largely use the metric system in their daily weighing and measuring of whatever may be done by them when it is required to make a record of it on paper.

Now, I think whatever is done should be done, and should be intended, in fact, with an eye to the future—that is, either we wish to use the metric system or we do not. If we do, some feasible plan should be evolved by the legislators who have the matter in hand—that is to say, by your committee—for completing the matter from start to finish before the first step is taken.

Mr. LANNING. Right there, Mr. Colles, let me call your attention to this fact, which perhaps other speakers, too, have not observed, that the bill before us is not a bill to enforce the use of the metric system throughout the country in all business. It is only a bill to enforce that system in the Government Departments, and not in business branches generally. I think, however, that the discussion that has been had is not out of its course at all, because the bill may be very properly construed as one that tends to introduce the system generally.

Mr. COLLES. Yes, sir.

Mr. GAINES. How do you construe this language, Mr. Chairman, in House bill 93, introduced by Mr. Shafroth and now pending before this committee.

* * * shall employ and use only the weights and measures of the metric system; and on and after the 1st day of January, 1906, the weights and measures of the metric system shall be the legal standard of weights and measures of and in the United States.

Mr. LANNING. That says, at the beginning:

That on and after the 1st day of January, 1905, all the Departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use, etc.

That means the Departments of the Government, not in business generally.

Mr. GAINES. I asked Mr. Towne what effect he thinks that would have on the manufacturers, and he said that they would not fill the bill.

Mr. LANNING. I thought I ought to call your attention to that particular fact now.

Mr. COLLES. I was coming to that, Mr. Chairman. I know that it is compulsory only so far as the Government is concerned, although there may be a question as to the last part. As to what is meant by the other bill, Mr. Shafroth may know. But I confine myself to the first section of this bill. That section is intended to promote the metric system. It is made, I say, with an eye to bring the system

into use all over the country. Unless that object is fulfilled you will agree with me, I think, that the bill will be useless, not to say pernicious. It would merely tend to create disagreement with the Government, without really bringing into effect the view you have in mind.

Now, it seems to me plain that some perfectly definite idea and notion and plan should be evolved for bringing the metric system into universal use throughout the country. As I stated before, I do not think those who are proposing the metric system to the country as a general thing can have any adequate idea of it. In Germany, perhaps, it was possible. But what machinery have we in the United States for enforcing a law of that kind? As Mr. Gaines said, in asking Mr. Towne about forcing manufacturers to use such and such measures and not to use such and such other measures, our laws and Constitution, gentlemen, I believe, are utterly and totally inadequate to enforce them.

Mr. John Quincy Adams came to the same conclusion in his report, I believe. But however that is, I can not conceive how the clause of our Constitution which gives Congress the right to fix the standards of weights and measures can give it the right to say what measure a man shall use—that is, whether he shall use a meter or a foot or a pound or a kilogram. You might legislate that the meter shall have such and such a length and the pound such and such weight; but to compel a man to use a foot or a meter, according to your fancy—according to the fancy of other individuals than the man who uses it—we do not believe it is a possibility.

Mr. COCHRAN. Would not that be accomplished by compelling litigants to bring action in meters instead of feet and inches?

Mr. COLLES. I do not know. It has not been accomplished that way in France. Simply for all written documents equivalents must be stated in metric measures. It would simply be that the legal papers would be less legible to the common people, and judges, perhaps, too, and also lawyers, than at present. [Laughter.]

Mr. GAINES. How would it be with justices of the peace in Tennessee, who are judges of the courts under the State constitution? Suppose they would give a judgment or render a judgment in dollars and cents affecting inches or feet or some transaction in which inches or feet were concerned. Then we would have to send some one all over God's green earth and get somebody to work that back into meters.

Mr. COLLES. The justices of the peace, you say, are officers of the State of Tennessee and not of the United States. The compulsory feature, as regards the general public, if it runs anywhere at all in the United States, lies with the several State governments and not with the Federal Government, which has no machinery for enforcing such a measure as that and never had any intention of enforcing such a measure.

Mr. GAINES. Do you not think we ought to print that report of John Quincy Adams?

Mr. COLLES. Yes, sir. I think it is more important that you do that than that you should print our testimony here, even if every item of it was left out, although the testimony of practical men like Mr. Towne is extremely important.

Mr. GAINES. What do you say to that, Mr. Towne?

Mr. TOWNE. I think it is extremely important—one of the most important contributions that has ever been made on the subject.

Mr. GAINES. What do you say as to that, Mr. Lodge?

Mr. LODGE. I think so, too.

Mr. COLLES. John Quincy Adams, as I understand, spent four years in the investigation of that subject before he made that report, and I do not believe that any member of this committee has given the same measure of attention to this subject that he gave. At all events, no reports made by Congress show it, and no report that has been printed shows the same amount of investigation.

Mr. GAINES. Those quotations which you sent me in that document are correct, are they?

Mr. COLLES. They are, sir. They are taken direct from the original document.

Mr. GAINES. I have not been able to get hold of a copy.

Mr. COLLES. It was printed, as you may know, by Prof. Charles Davis in his report at the University Convocation of the State of New York in 1871, but that has disappeared from the market. It is a rarity now.

Mr. LANNING. Was it not reprinted in a magazine some years ago?

Mr. COLLES. I do not know, sir.

Mr. GAINES. He reported squarely against this system, did he not?

Mr. COLLES. His report is somewhat quizzical, but an impartial person must get the impression that the report is against taking a positive stand upon the subject at that time. John Quincy Adams said many things in favor of the metric system, and many things against the system, and some of his expressions are really very cloudy, which do not really refer to the practical measure we have in hand. But as you stated in the case of Mr. Towne's testimony, he did undoubtedly come to the conclusion, and stated it squarely in the end of his report, that it would not be—pardon me, but I do not quite remember the exact language at this time, but the substance of what he said was—that it would not be practicable or wise at that time for Congress to undertake such a sweeping measure. That was in the year 1821.

Mr. CANDLER. If it was not feasible then, practically at the commencement of the Government, it would be a thousandfold more difficult now, do you not think?

Mr. COLLES. Yes; fully a thousandfold more difficult now.

Mr. GAINES. Did he not say that the metric system at that time had not been as fully developed as France afterwards developed it?

Mr. COLLES. Undoubtedly; and he was induced to it partially, no doubt, by the efforts of Napoleon in introducing the usual system, which comprises a hybrid mixture of French measures and the metric system—a mixture which was in use in his time. He doubtless hoped, in view of his report, that some such compromise would be introduced as that. Remember that the ordinary French system was like ours, divided into duodecimals and not decimals; and it was the decimals that the people objected to, and which they still will not take up. And at the present time they still have their pounds and quarter pounds in France, and their half acre, and so forth, or their half hectare, and so forth.

Mr. TOWNE. That shows the binomial method is natural to the human mind, does it not?

Mr. COLLES. Yes; for the same reason that in Germany they still adhere, I believe, to eighths, and sixteenths, and sixty-fourths—divisions of that kind. I took that from the German law promulgated, I think, in 1892, or possibly a little earlier, which insisted that those measures be not longer used, although they had been permitted up to that time. The fact that that is in the text of the German law, a copy of which I have, shows that they evidently must have been in common use, and the legislators were still struggling with it to compel the use of the decimal division.

Now, the point I wish to make is this: That Congress, before taking any step, ought to ascertain the feasibility by a thorough investigation, by men whose time should be devoted to this subject for a sufficient length of time, and ascertain the feasibility of that change, and not go ahead and take an initial step which will not be possible to complete.

The same was the case, you remember, some years ago—not very many years ago—when a gentleman was trying to secure the authorization of incipient legislation for an isthmian canal before adequate estimates had been made or prepared. That is a fair sample of how, from the standpoint of an engineer, one must always have one's plan mapped out in every detail and perfected in detail before you can wisely take the first step, before you act, before you take the first step of actual execution.

For that reason, if any step is to be taken in this matter at all, I am strongly of the opinion, and I strongly urge, that it be taken in the shape of appointing and organizing a special commission such as I have spoken of, to investigate the subject of the metric system, which as Mr. Towne stated, should be composed of all classes of interests, and particularly of those who have the greatest use for weights and measures.

Mr. GAINES. In other words, we ought not to start the policy of the Government using the system unless the American people will have to use it also.

Mr. COLLES. Exactly; yes, sir.

Mr. LANNING. Do you agree with Mr. Towne and Mr. Hobart in the idea that there might be a wise unification of the different systems we have now of weights and bulk measurements—of those two classes of measures?

Mr. COLLES. Yes, sir; I was going to bring that up as the last point of my argument. I had a few other things in mind which I was going to speak of; but I will say now, so far as the English system is concerned, this country has never undertaken any adequate measures to improve or perfect our existing system. It has never taken any measures worth mentioning toward standardizing the system. The only act of importance was the furnishing of standard yards and pounds to the various States, back in the thirties. But since that time the Government has done absolutely nothing. The manufacturers have done it all. And as Mr. Towne and perhaps others have shown, they have done more to make this country productive from a weight and measure standpoint than has been done in any other country with all the laws that have been passed there.

Mr. COCHRAN. I would like to ask a question that occurs to me in that connection. What system of weights and measures is current in oriental countries—that is, measurements of bulk and so on? What system is in vogue in the oriental countries? Is it a decimal system, or is it one of their own, and peculiar to themselves?

Mr. TOWNE. A great variety. In China they have their own—the Chinese system, which is used by European merchants there. In Japan——

Mr. COCHRAN. Is that a decimal system?

Mr. TOWNE. I think not.

Mr. GAINES. I think I can answer my friend's question in a general way. We had Professor Halsey and others here not long ago, and Mr. Halsey and Mr. Dale have issued a book called "The Metric Fallacy," which states the different systems employed in the Orient and everywhere else; and then some one else who has testified here said he had been consulted as to whether or not the Halsey and Dale statement was correct, and he said it was practically correct.

Mr. TOWNE. I would like to supplement that by saying that I am sure that Mr. Halsey has brought together in that book the greatest mass of facts ever assembled as yet of arguments against the adoption of the metric system. But I regret to say that some of his statements are somewhat intemperate, although his facts are correct.

Mr. COLLES. I would like to second Mr. Towne's remarks. Mr. Halsey's book gives you a greater aggregation of facts there than there has ever been produced before. It will be a valuable addition to the testimony which the Weights and Measures Committee have before them for their consideration.

Now, before I say anything about the improvement of our present system, I would like to touch upon one or two other things and bring them out. What has the British Government been doing? While we have been doing nothing, legislatively speaking, our British friends have been doing a great deal. We have been repeatedly told that Great Britain is about to adopt the metric system. Now, Great Britain looked into that matter—perhaps a hundred years ago. In 1812 the first commission was appointed, and a number of other commissions have been appointed since. Practically all of them that have made a study of the subject, as shown by the reports, have given their word as against compulsory legislation in favor of the metric system.

Mr. GAINES. Were they scientists, or plain men and manufacturers?

Mr. COLLES. They were both. The first one was composed of scientists. They were opposed to it. On that commission were Dr. Thomas Young, the author of the wave theory of light, and Capt. Henry Kater, one of the chief members of the weights and measures department of Great Britain. And the second committee contained Lord Wrottlesly, who was very much interested in it, and Lord Monteagle, the governor, I think, of the Bank of England, and Mr. Babbage, who invented a calculating machine—one of the first and best—and a great many others. Sir John Lubbock, and Mr. Peacock, and Sir John Hehschel, the astronomer, were on the committees from 1835 to 1843.

Mr. GAINES. They reported against it, did they?

Mr. COLLES. Yes, sir. But in fact the change of weights and measures seemed to them so hopeless that they did not lay so much stress on it, or so much stress was not laid upon it afterwards. What they did want, however, was a change of the coinage system. Most of the other countries have a decimal coinage, and the advantages of it are manifest. But in spite of their advocacy of a change and favoring decimal coinage, the British Government refused to act. They did, however, coin a 2-shilling piece, which they termed a tenth of a pound. That is as far as they got. Mr. Gladstone, who was chancellor of the exchequer, refused or declined to act on the question as to other coins, and after considerable debate in Parliament they meant to have a further investigation, although they had already several; and they appointed a royal commission, consisting of Lord Monteagle, Lord Overston, and J. G. Hubbard, governor of the Bank of England, who reported even against that change. The public sentiment in favor of that was high.

I state these things merely to show how conservative the Government of England is, and that it is in fact behind the people, and not before them, in making changes. The British Government, after twenty years of public agitation, which has probably never been equaled in any other country on a like subject, has not been able to get a decimal coinage; and I do not think there is the slightest possibility of their adopting the metric system of weights and measures in any reasonable time. And all the committees that have been appointed on such questions since then have been appointed without due consideration, and not much attention has been paid to them either.

Mr. GAINES. I was told over there this summer that it was the purpose of England to adopt our system of decimal coinage in the next seven years.

Mr. COCHRAN. You think the power resides not in Congress, but in the States, do you? And therefore the bill before Congress now, or any other bill passed by Congress, would not move the manufacturers, but would leave the manufacturers and automatic machines at liberty to pursue their own course as to what measurements they would use in their own business? And it might even happen, might it not, that on account of the difficulty of the change it would continue that way indefinitely? While, on the other hand, if it is more convenient, the metric system will become the means of expressing weights and measures in contracts and accounts in clearing houses and the like? Do you not think that would be the case?

Mr. COLLES. You mean the present system would continue in use?

Mr. COCHRAN. Yes, sir.

Mr. COLLES. I will answer Mr. Gaines's question first. He said he heard that England intended to adopt our decimal system of coinage in seven years. Of course I do not know who told him that. It may have been some officer of the Government. But when you come to speak of the English Government as a whole, it is a rather indefinite thing. There is no person there authorized to speak singly.

Mr. GAINES. I got it in generally talking around, but I did not run up against the Government over there at any time. It was said that our money was having such an influence over there and they dealt with it so much that the people had fallen in love with our decimal system, because it was so easy to count.

Mr. COLLES. Yes; in certain respects. But the British Government is so conservative and so much in love with their own British pound that I do not believe they would change their pound for any other coin, either now or at any time in the future. In the International Monetary Commission, in Paris in 1869, they refused to engage with the other delegates on the question of changing their pound.

Mr. COCHRAN. Was not that a discussion of coining international money?

Mr. COLLES. Well, it was to a certain extent. But the British Government has taken practically this standard, and although they are willing that other nations shall change their money to the pound, they are not willing to change their pound to the coinage of any other nation.

Mr. COCHRAN. I recollect that the proposal in 1869 was not to change the domestic coinage, but it was a proposal to have one international coinage, and the only change incident to the international coinage was to make their accounts on the decimal system harmonious with the international coin.

Mr. COLLES. That was a very beautiful thing, and I agree with you that the benefits of that would be great.

Mr. COCHRAN. Was not that what the English refused to do?

Mr. COLLES. That exact point, I believe, had not been brought up; but it was, of course, a part of the general question as to the unification of the coinage.

Mr. COCHRAN. My recollection is that the convention was called for the sole purpose of discussing weights and measures, and some enthusiastic brother in the convention stated that a question of greater importance, if possible, was the unification of money; and it was only looked upon as an incident to a convention called for another purpose.

Mr. COLLES. I think that statement by the British delegate was in regard to the decimalization of the British money. They took the ground that the advantage of the decimalization had not been demonstrated.

Now, in the question of money, there is a greater chance of getting something truly international and valuable than in the question of weights, because over there the Government has the whole control of money, and it needs only the decision of the Government, or the decision of a number of governments, to decide on an international money. So there you have a far easier question than in the case of weights and measures. Weights and measures are absolutely beyond the control of the governments, as experience has shown—even the experience of most autocratic governments, because they have not the power to investigate what is being done by Sam Jones and John Smith, and they can not keep watch on people, and can not compel people to think otherwise than as they have always thought.

The powers of a legislature in any country are limited. But particularly they are limited nowhere so much as they are in the United States. Here Federal control is limited by the Constitution and preserves to the States their rights to decide as to matters of what I may call police jurisdiction; and that is what a compulsory law in favor of the metric system ultimately comes to.

Now, there are two small points which I would like to make before

I conclude. One is in regard to electrical units, which I have heard many times spoken of as metric. We are told that of course that as the metrical engineers are using metric units those units are being largely used in this country. As an electrical engineer I wish to say that the electrical units are not metric. They are founded on the C. G. S. system, which is, I may say, derived from the metric system, but with itself bears no useful relation whatever to the metric system. To prove this I cite the fact that the electrical unit of power, which is the watt or kilowatt, is incommensurable with the metric unit of power. Seventy-five kilograms per second—that and the kilowatt are incommensurable. One bears relation to the other something like 0.1019, plus or minus.

Mr. LANNING. Please give that figure to the stenographer.

Mr. COLLES. Very well, I will.

However, it is an incommensurable fraction. That is part merely of a fraction, anyhow. The three electrical units which are in common use—the volt, the ampere, and the kilowatt—have none of them any sensible relation whatever with the mechanical unit, and the derivation of them, in fact, is by such an abstruse process that I do not believe one electrical engineer in a hundred, or probably one in a thousand, could give it to you offhand. It involves various considerations, none of which have any practical use.

Mr. GAINES. Electricity in a practical way is rather in its infancy, is it not?

Mr. COLLES. Yes, sir.

Mr. GAINES. And to change the machinery by which it is bridled now would not be comparable to changing any of the old systems of manufactures? In other words, being a new system, they have not comparatively many tools involved in it?

Mr. COLLES. Comparatively speaking; but they have still a great amount. I do not understand what changes you refer to, however.

Mr. GAINES. I understand you say in the electrical system you are using the American system.

Mr. COLLES. Yes, sir.

Mr. COCHRAN. You are referring to the measurement of electrical power?

Mr. COLLES. Yes, sir. It is the only system that is used in the world. I do not think there is any suggestion to change this system to the metric system—to a standard which would make the electrical unit of power commensurable with the metric unit of power. The whole world at present uses but one system. The money invested in the electrical industry, as regards stands and resistants and battery——

Mr. COCHRAN. The system you speak of in electrical science is neither commensurable with the metric system nor with the English system? It stands by itself?

Mr. COLLES. Yes, sir; it stands by itself. There is no way of getting any practical relation between them, anyhow; so that it does not make any difference. We know that the mil foot, as it is called, has a resistance of 10.74 ohms.

Mr. COCHRAN. A proper way to state it would be, that what the electricians do is foreign to this matter?

Mr. COLLES. Yes, sir. I do not think any more electricians use the metric system for mechanical measurements in this country than machine-tool builders do.

Mr. TOWNE. They use the inch and foot for all units of length?

Mr. COLLES. Yes, sir.

Mr. HOBART. I think that Mr. Gaines's question to you, Mr. Colles, was not perhaps fully understood by you. The question of the metric system in the electrical industry must be taken from the manufacturing standpoint in the same way that it is taken in the machine-tool industry.

Mr. COLLES. Yes, sir.

Mr. HOBART. I think you will agree with me that there are few, perhaps no manufacturing industries in this country, that have a larger investment in machine tools than the Westinghouse and the other electrical establishments.

Mr. COLLES. Oh, yes. They are on the English system.

Mr. DRESSER. But the power of the electrical machine is measured by a different system?

Mr. COLLES. Oh, yes; it is a more or less arbitrary system.

Mr. GAINES. What I was trying to bring out was this: If a man invents a machine he can go along and make it to the metric measure, and hereafter it would not incommode him to reproduce that. In the case of electricity, which has been developed in more recent years, there could not be as large an investment as in older businesses.

Mr. COLLES. It is comparatively new, but it is none the less well developed. For instance, international commissions have sought to determine the true value of the ohm, the unit of resistance of electricity; and its derivation from mechanical units is so abstruse that it has been impossible to get the true ohm, and probably it will never be got. It is like getting the length of a second pendulum.

Now, the change which has been brought about by these attempts to get the true value of the ohm has been very small indeed, and yet I have heard an electrical professor—Mr. Crocker, of Columbia University, who said he had lived through three ohms, and hoped he would not have any more of them. [Laughter.]

The point I wished to bring out was that, so far as electrical units are concerned, I can not see where they bear any relevancy to the metric system.

Mr. LANNING. I understand you mean the unit of measurement of electric power?

Mr. COCHRAN. It relates to the measurement of electricity, and not to the machine used?

Mr. COLLES. Yes, sir.

Mr. LANNING. You are speaking of the unit that is used in ascertaining or measuring electrical power?

Mr. COLLES. That is it, sir.

Mr. COCHRAN. And you are not speaking of the current that is used in the manufacturing of an electric machine, and therefore the whole subject is irrelevant?

Mr. COLLES. Yes, sir.

Mr. LANNING. Is there any theoretical or practical relation between the electrical unit and the other metrical unit, or the unit which we use in all ordinary standards of weights and measures?

Mr. COLLES. There is a theoretical relation, but no practical relation. It relates, in other words, I may say, to the velocity of light, and, as I say, it is so very abstruse that it does not concern anyone outside of a laboratory, and even then only those engaged in inves-

tigations like those of X-rays and other scientific inventions, which have no practical constructive value, and probably never will have.

Mr. LANNING. Now, Mr. Colles, we will have to adjourn in a very short time.

Mr. COLLES. I want to make just one more point, Mr. Chairman. I did mean to say, for one thing, that at any rate the exports to Great Britain and her colonies are in excess of those to metric-using countries, and so far as there is any argument at all brought from that it would be against rather than for the adoption of the metric system here.

But the final point I would like strongly to urge upon the members of this committee is that they will consider, in the light of our present system, what ought to be done.

That, so far as I know, has never received adequate consideration from the committee. For thirty years the committee has been engaged totally, so far as I know, judging from their reports, in trying to get a metric bill passed, and not in trying to get a unification of our weights and measures. As Mr. Towne pointed out, and as was also pointed out by Professor Reeve in 1902, our measures are capable of a considerable amount of improvement without interfering with commerce and trade at all. The foot and the inch can not be changed, but the fact that a bushel, for instance, consists of 2,150.42 cubic inches indicates that it ought to be changed. I do not think that is an argument against the present system. But it ought to be changed.

Mr. GAINES. You would still be in favor of calling it a bushel.

Mr. COLLES. Yes, sir. I would make it 2,160 cubic inches, an even number without a decimal fraction; and the same in the case of the gallon. I would take it back to what it originally was.

Mr. COCHRAN. You would resolve it into eighths, quarters, and sixteenths, and all that?

Mr. COLLES. Yes, sir. I am talking about what is feasible. The people in general will not measure by decimals. In general use people will speak of sixteenths. The Government has not the power to compel them. Therefore the effect of a bill compelling the people to use the metric system would simply be to introduce a certain amount of confusion, difficulty, and expense. As Mr. Towne very justly stated, to suppose that American manufacturers are going to change their measures for any law whatever is, I think, to suppose an impossibility. I think it an impossibility. They can not do it.

Mr. GAINES. The farmer sells his potatoes by the bushel and his wheat by the bushel and his corn by the bushel. Now, he goes to the man and buys a bushel measure, and that bushel is made by some manufacturer. He does not sell his corn by so many cubic inches, and so on. The farmers are not complaining. Why do you want to make any change at all?

Mr. COLLES. I do not say absolutely that any change should be made, but I say that could be done.

Mr. GAINES. If they sold or bought by cubic inches it would be a different thing; but they buy by the peck, and the gallon, and the pint, and the quart.

Mr. COLLES. The only use of that would be for the sake of facility in calculation, which is a great advantage put forth by the advocates of the metric system in storing grain in ships, etc. And the gallons

are used by engineers every day in measurements of bodies of water, and so on.

Mr. GAINES. But the farmer, if he wishes to put his wheat away in so much cubic space, knows how many cubic feet are necessary.

Mr. COLLES. I would not be understood as favoring absolutely any particular changes, or any change; but what I want to bring out is that our present system ought to be considered, with the object of unifying and developing that, if possible, or advisable, or feasible.

Mr. GAINES. Now, you yourself do not use the peck, or the quart, or the pint. Then you are not an expert in this. Then you are a professor in this.

Mr. COLLES. No; I am an engineer.

Mr. GAINES. Rainbow people want this metric system, and the practical people do not want it. And when you want to change the bushel into something else you become yourself one of these rainbow chasers. [Laughter.]

Mr. COLLES. No. I suggest that before any change whatever is made by the Government, or advocated by the Government, or passed by the House of Representatives, Congress should be well advised, and by a national commission, after having made a full and complete study of that subject, not having simply heard testimony from other people, but after having made their own investigation of the subject in addition.

Mr. LANNING. And in that respect you join in the recommendation of Mr. Towne?

Mr. COLLES. Yes, sir; I do.

Mr. LANNING. In other words, the general position you take in relation to the matter before us is that it would be impracticable and expensive beyond all present means of computation to make the change suggested?

Mr. CORLISS. That is his way of looking at it. My way of looking at it is that it can not be done at all.

Mr. LANNING. Because it is a matter controlled by business habits and experience, and no mere man-made law can effect a change.

Mr. COLLES. Yes, sir.

Mr. COCHRAN. I only want to make one suggestion here. Is it not true also that, so far as the sale of a very large part of farm products is concerned, the only thing possible is an approximation of weights and measures? Corn, for instance, in October is much heavier than corn measured in the following spring, and the consequence is that in the sale the buyer and seller agree to an arbitrary weight per bushel. For instance, they will add 5 or 6 pounds on certain commodities in the green state, and when they are dried out in preparation for foreign market they will drop so many pounds, so that anything more than an approximation is impossible.

Mr. COLLES. That is very true, and therein lies the impracticability of the metric argument.

Mr. LANNING. The time for adjournment has arrived, and the committee will now adjourn.

Thereupon, at 1.10 o'clock p. m., the committee adjourned.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., February 25, 1904.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. You may proceed, Mr. Wharton.

STATEMENT OF JOSEPH WHARTON, PRESIDENT OF THE AMERICAN IRON AND STEEL ASSOCIATION.

Mr. WHARTON. Mr. Chairman, I will begin by reading a letter from our association to the chairman of this committee:

PHILADELPHIA, *February 24, 1904.*

DEAR SIR: In behalf of the iron and steel manufacturers of the United States, represented by the American Iron and Steel Association, we respectfully and earnestly protest against favorable action being taken by your committee on House bill No. 93, which proposes to make the use of the metric system of weights and measures compulsory in the transaction of business with the Government and between individuals. We know of no general demand for this proposed radical change in our system of weights and measures. We certainly do not know of one iron and steel manufacturing company which desires that this change be made, either now or at any future time.

Very respectfully, yours,

JOSEPH WHARTON, *President.*
JAMES M. SWANK, *General Manager.*

The CHAIRMAN. Will you tell us, Mr. Wharton, how you and apparently so many of the manufacturers got the idea that the legislation pending in this committee was intended to make the metric system compulsory generally with the people, as that letter states?

Mr. WHARTON. Suppose we turn to the language of the bill:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the first day of January, nineteen hundred and five, all the Departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system.

That is one clause or feature of the bill. That takes effect on the 1st of January next year if it becomes law. It then proceeds:

and on and after the first day of January, nineteen hundred and six, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States.

We take that to mean that, if the weights and measures of the metric system are going to be the legal standard of the United States, anything that gets into court would have to be translated into the metric system; that anybody who is doing business in the old-fashioned way, with the old-fashioned weights and measures, would be at a disadvantage by not having used the standards ordained by the law, and would be obliged in some way to conform to the then legal standard. Of course, people between themselves can conduct their business in any way the two parties may agree to. A man may sell peaches or corn by the basket, and those baskets might be of any customary size understood by the parties. There need be no legal standard as to that transaction; but when two persons get into a legal contest concerning anything usually dealt in by the ton or pound

or gallon, then I presume the effect of the proposed law would be that they have got to show up their statements according to the new legal standard. Is that your idea, sir?

The CHAIRMAN. I only wanted to get your idea. My idea would be that, so long as there is nothing in this bill making the use of any weights or measures illegal, that language in the bill is largely surplusage.

Mr. WHARTON. Well, can there be two legal standards of weight in the country, and if there is one set of weights that is the legal standard and another set of weights that is empirical or local or merely habitual, no matter how generally used, would not that latter class have to give way to the legal standard?

The CHAIRMAN. Suppose, for instance, you sell a piece of land, taking an extreme case, and supposing the dimensions of that land are stated in Spanish varas, we will say, do you have an idea that that contract would be illegal because of the fact that it was stated in Spanish varas?

Mr. WHARTON. I answer your question by remarking that in cases of transfers of land the thing which really regulates the business is the boundary, the metes and bounds.

The CHAIRMAN. If there were two descriptions, one being a description by metes and bounds and the other being a description indicating the number of rods or feet or acres, the description by metes and bounds would prevail?

Mr. WHARTON. Yes.

The CHAIRMAN. That is a rule of law, as I understand it.

Mr. WHARTON. Yes.

The CHAIRMAN. But supposing there were only one description; supposing that you should sell corn in this country, or make a contract for the sale of corn, and the quantity should be stated by any foreign term having a definite meaning which could be ascertained—would it render the contract illegal because of the fact that it was not stated in terms employed by our system of weights and measures?

Mr. WHARTON. I do not think that a contract otherwise valid could be adjudged invalid on that account. A plea for specific performance might prevail. But the wording of the proposed law might lead a court to decide that the terms of the contract should be translated into the legal-standard terms and judgment be rendered in those terms.

The CHAIRMAN. Have you any idea that a contract of that kind would be held to be an illegal contract? Is it not obvious that a court before whom a contract of that kind should come for determination would simply arrive, in the best way possible, at the intention of the parties?

Mr. WHARTON. Yes; I should say so. We used to have in the city of Philadelphia a system of ground rents payable in Spanish milled dollars, weighing each 17 pennyweights and 6 grains. I suppose that system of conveyancing originated before we had any fixed system of coinage in this country; but it prevailed up to my time, and I have had to do with that kind of ancient ground rents where the rents were payable in Spanish milled dollars, a thing that was not in accordance with any system of United States money, and the courts, I believe, always upheld it.

Mr. HEDGE. It is upheld now, Mr. Wharton. If you made such a contract to-day, it would be enforced.

Mr. CANDLER. The court would uphold the contract, and it would be legal, but would not the judgment of the court have to be rendered in our money? For instance, you could make a contract, as is sometimes done in my country, providing that so much rent will be paid for a piece of ground, payable in so many bales of cotton; and if you go into court and sue on that contract you have to prove the value of the cotton in dollars and cents.

Mr. HEDGE. Of course the judgment is rendered in our money, but the contract is just as good.

Mr. CANDLER. The contract is binding, of course.

The CHAIRMAN. Suppose the judgment of the court was rendered otherwise, would it not be of equal force and validity?

Mr. CANDLER. You could not enforce the judgment. The only way to enfore the judgment is the collection of it in money, and if the court should render a judgment for so many bales of cotton——

Mr. HEDGE. The court can require the delivery of so many bales of cotton.

Mr. CANDLER. Or the value.

Mr. HEDGE. It can do it specifically, if that is the proper remedy.

Mr. CANDLER. But if you were to go into court and sue on a contract for so many bales of cotton without proving the value of the cotton and stop without proving the value of it in dollars and cents——

Mr. HEDGE. That is not the question. The question is the validity of the contract.

Mr. CANDLER. The contract is valid.

The CHAIRMAN. The reason I asked the question, Mr. Wharton, is this: An impression has gotten out—I can only imagine how it got out—that the purpose of this bill is to impose upon the business interests of the country in a compulsory way the general use of the metric weights and measures.

Mr. WHARTON. Our impression is that the persons who originally conceived this bill intended to reach just that end; they intended that it should ultimately become compulsory. We, however, regard its language as being ambiguous, capable of being looked upon from what I take to be your point of view as being merely a sort of invitation, a system held out which may be adopted by persons in their private dealings, but not compulsory. But the same language seems to us to imply that the real operation of the law shall, in fact, be at last compulsory; though additional legislaiton may be needed to make it so, for we observe that in other countries where the metric system has been introduced by law it has been found necessary to ask compulsory legislation to make it go, since people naturally adhere to the old weights and measures.

Even in France, where the metric system originated, there are calls for more compulsory action to make it obligatory, to drive out the old weights and measures. Let me add a remark about this Spanish milled dollar business. I never knew a rent to be paid in the absolute Spanish coins. They have always been translated into American money, so that when the payment came to be made the person receiving the rent has been satisfied to receive the ordinary current money, only holding the covenant for coins over the

debtor as something that may be demanded if there is any change in our standard or if in any way the current dollar here should be of less value than the stipulated Spanish silver dollar of fixed weight.

Mr. CANDLER. You pay the equivalent in American coin?

Mr. WHARTON. The equivalent was always paid in American money.

Mr. HEDGE. And probably with a check?

Mr. WHARTON. Yes; I knew of an important case of the kind in Philadelphia; the old Powel estate on the west side of the Schuylkill was purchased by the Pennsylvania Railroad Company, a large part of the purchase price being represented by a ground rent payable in Spanish dollars. The heir of that ground rent was a good deal exercised during the civil war as to whether that stipulation for payment in such coin could be evaded and payment made in legal-tender paper, but in point of fact the railroad company acted honorably and did not attempt to evade paying in coin, or rather in its equivalent.

Passing now from the compulsory features of the bill, and from all relating to private transactions, and returning to the part relating to Government transactions, we observe that it introduces into all the manufactures carried on for the Government the necessity of operating by the metric system. A man contracting to build a ship, for instance, or to supply materials of any sort, or to furnish food, would seem to be obliged to have everything done by the metric system. A man could not, for instance, sell to the Government so many barrels of flour or pork, because there is no metric system about the barrel of flour or of pork. Anything the Government may need must be made or provided according to the metric system; and in the case of ships or machinery all parts of the complicated construction would have to be done by a system that the workmen do not understand. It looks to us as if it would be an aggravation of what is now impending as to the eight-hour law. It would be an exceedingly ungracious thing for one party to a contract to introduce an element of compulsion which is offensive to the other party, and the party so compelling would have to pay, in higher prices, for so doing. If the eight-hour law and the metric-system law should be made to apply to the Government work and to stop there, they might be endured by charging proportionally higher for all Government work; but it is obviously intended that, although obligatory in the first place only as to Government work, they would both in time become compulsory in all private dealings, which would make business complicated and troublesome to a degree that I suppose persons not engaged in manufacture or trade could hardly understand.

Everybody who is making iron or cloth knows what he is doing when he buys a ton of coal or iron ore, or so many pounds of cotton or wool, and when he comes to sell the product by the ton or pound or yard everybody knows what he is doing. It is like the mother's speech; he does not have to think. But if he has to do all those things by the metric system he can not make a bargain or employ a workman or carry on any part of his business without having to study the meaning of all this in the metric tongue of weights and measures, to which he has not been accustomed. The toil and labor and inconvenience of such study are, I think, hardly conceived by persons who have not been in the turmoil of actual business.

Without going into detailed argument upon all the points that

might be urged against this bill, we have thought the most effective course for us to take in regard to it is simply to state our strong conviction that the thing is not wise. The American Iron and Steel Association, on whose behalf I speak and of which I am president, does not pretend to have anything to do with the manufacturing or commercial affairs of that numerous and influential body, the iron and steel makers of this country, most of whom, but not all, belong to the association, which forms a bond of union among them so that they can have a united voice when occasion arises to speak in legislation or in other matters.

The enormous operations of these manufacturers constitute the backbone of the nation's industries. Their employees, direct and indirect, amount to many hundreds of thousands. They well understand all the branches of their huge affairs, so that their conviction upon any point touching their business is entitled to respectful consideration, even if not so skillfully stated as to carry conviction to the minds of the committee, for those convictions have been reached through the close and continuous experience of many competent judges. They are an important part of the public from whom the powers of legislators are ultimately derived; their expressed choice and will that such a thing should be done or should not be done can not be lightly set aside.

I say this with all respect to the committee, merely putting forth what seems to me to be the ultimate right of the persons doing so great a part of the indispensable business of the country.

The CHAIRMAN. What is the name of your association?

Mr. WHARTON. The American Iron and Steel Association. You will find it on the head of that letter.

The CHAIRMAN. Is it an incorporated company?

Mr. WHARTON. It is not. It is a mere voluntary association of the iron and steel makers and dealers in the United States.

Mr. CANDLER. How many concerns are connected with your association?

Mr. WHARTON. I am really unable to answer. I do not know the number.

Mr. CANDLER. About how many?

Mr. HEDGE. What proportion?

Mr. WHARTON. That is also difficult to state. For instance, the United States Steel Corporation, which itself operates more than a majority of the iron and steel producing establishments of the United States, is one of our associates, and of course the principal one. I do not know whether they have spoken to the committee.

The CHAIRMAN. I do not know that they have, directly.

Mr. WHARTON. We have the assurance of their sympathy, and if their president, Mr. Corey, were in the country I suppose he would have come here with me.

The CHAIRMAN. Do you think there are any advantages to be derived from a universal system of weights and measures, assuming that such a thing could be had?

Mr. WHARTON. Throughout the world?

The CHAIRMAN. Yes.

Mr. WHARTON. There would be some convenience in it, but I think the convenience has, perhaps, been overestimated. When, for instance, money transactions are going on between the United States

and Great Britain there is very small inconvenience in arranging the exchanges between the countries, though their money systems differ. It is the same in our dealings with the French system and the German system of money. They are all different from ours and yet there is no practical difficulty, as you know, in arranging the exchanges between these countries. Nor do the differing languages or the differing weights and measures of the various countries seriously interfere with free commercial intercourse between those countries.

The CHAIRMAN. Do you think there is any tendency toward a decimal system of weights and measures throughout the world?

Mr. WHARTON. I do not think myself competent to answer that question, Mr. Chairman, in such a manner as to deserve much attention. You doubtless know that some people think the whole decimal system is merely an accident; that we might just as well have had a system of figures divisible by two all the way down—8, 4, 2, 1.

The CHAIRMAN. That is, at the beginning we might have adopted a different system?

Mr. WHARTON. Yes. In other words, the Creator did not have a decimal system in his mind in creating the universe. If everything ought to be arranged on a decimal system, why not time as well as space? Why not abolish the hour and take for our time unit the ten thousandth part of the solar year?

The CHAIRMAN. But we did adopt the decimal system of notation. In some way we got it.

Mr. WHARTON. Yes; and it is so convenient that we now hardly think of the possibility of any other.

The CHAIRMAN. Do you think there would be an advantage if we could make our system of weights and measures accord with our system of notation?

Mr. WHARTON. I am not clear about that. We have our system of weights and measures now on what you might call the quadration system—that is, dividing by two all the way through—and that, I fancy, is just as convenient as the decimal system.

The CHAIRMAN. Is not that more in statement than anything else? Is there any system you can imagine of weights and measures that will not lend itself with almost equal readiness to what they call binomial subdivision, halves, quarters, and eighths?

Mr. WHARTON. Yes; that is the point I am trying to make.

The CHAIRMAN. Does not the metric system lend itself to that kind of subdivision with almost equal readiness?

Mr. WHARTON. The first time you divide 10 by 2 the result is 5 units, but when you come to divide 5 by 2 you get a unit and when you continue dividing by 2 you get worse as you go on.

The CHAIRMAN. But if you take any unit in the metric system you can halve it, quarter it, divide it into eighths, the same as any unit in any other system, could you not?

Mr. WHARTON. That does not seem to be contemplated, because the names have been given for all the divisions by tenths.

The CHAIRMAN. But is there any objection to it so far as you can see?

Mr. WHARTON. Well, you divide a meter or a liter into halves or quarters, and so on, but by doing so you depart from the decimal sys-

tem; it seems to me that as soon as you attempt to use the binomial system you abandon the decimal system.

The CHAIRMAN. But if it is more convenient, as it seems to me to be in some cases, there would be no objection to it. It would be a matter of convenience, would it not?

Mr. WHARTON. Yes; a matter of convenience to speak of half meters, quarter meters, and so on, if convenience is meant to signify the comparative expenditure of energy or time, but to that extent the decimal system is set aside.

I am not aiming to say anything against the decimal system as a whole, as an abstract proposition. The weight of my argument, so far as it is an argument, is in favor of that which we have grown up under, which everybody in the country understands; my opposition is to the introduction of another system which will oblige most of us to go to school again. As a matter of purely scientific weighing and measuring, every scientific person, with very slight exceptions, has already adopted the metric system, and it has become what you might call a universal language in chemistry and physics; but that is confined by the nature of things to educated persons who have, in all the colleges and universities and even schools, been trained to that system.

Anybody who studies chemistry now must of course take up the metric system. Students begin young, and they learn to think in that way, and it is on that account, I think, that most of the professional men—I mean the professors and teachers in schools and colleges—are advocating the metric system. I think you will find a majority of them probably doing so simply because they have done it in their laboratory work and their office work, and have learned the language of the system. But it is quite posible to overestimate the limit which ought to be allowed to these professors. They are, after all, mere human beings.

I do not know whether any of you are old enough to remember the atrocious murder committed by a Professor Webster, of Harvard. Shortly after Webster's execution a case was being tried in Boston in which Benjamin F. Butler was the attorney for the plaintiff, and the attempt was made by his opponent to create a presumption in favor of the defendant because he was a Harvard professor. Butler said, "Oh, there is no use talking about your professors; we know about your Harvard professors. We hung one of them the other day."

It must not, however, be supposed that all theorists or philosophers favor the metric system, for I lately read that the deservedly famous Herbert Spencer, recently deceased, devised a special fund to be used in combatting that system.

The CHAIRMAN. Yes; I remember when I was going to school we had a professor of chemistry whose name, I think, was McKeever, and he was illustrating in the laboratory along the line of electricity. I remember a statement of his then that electricity could be used as a power, but never would be because of the expense of its production.

Mr. CANDLER. You know of no general demand throughout the country among the rank and file of the business men in favor of the metric system, at all?

Mr. WHARTON. I not only do not know of it—I do not believe that it exists.

Mr. CANDLER. There is no practical necessity for any change?

Mr. WHARTON. I do not think the business men of the country have given much serious attention to it. They look upon it as a kind of vagary that gets into some people's minds, but they think that the chance of its ever being adopted is so light that they do not worry themselves about it.

Mr. CANDLER. The expert theorists advocate it, but the practical business men oppose it?

Mr. WHARTON. I should rather say that the practical business men have not considered it worthy of very serious attention. They think it hardly among the range of possibilities that the thing would ever be brought into our law, yet, as their silence might be regarded as approval, some of them make this protest against it.

The CHAIRMAN. The time for us to adjourn has arrived. If you wish to supplement your statement by anything, Mr. Wharton, you may give it to the stenographer.

Mr. WHARTON. Would it be in order for me to leave this slip from the Iron Age, to be inserted? The Iron Age is a newspaper which represents in a great degree the iron industry of the country.

Mr. DRESSER. It is published in Pittsburg, is it not?

Mr. WHARTON. Not in Pittsburg, but in New York. This article merely gives a statement of the views that are held by many persons in the iron business, and unless it is out of order I will add it as a supplement to my remarks, in further illustration of the views of the people that I am trying to speak for.

The CHAIRMAN. Oh, no; it is not out of order. Do you want the whole article published?

Mr. WHARTON. Yes; I should say so.

The clipping referred to is as follows:

[From The Iron Age, New York, Thursday, February 18, 1904.]

THE BILL TO STANDARDIZE THE METRIC SYSTEM.

The Committee on Coinage, Weights, and Measures of the House of Representatives now have under consideration, introduced by Mr. Shafroth, of Colorado, a bill whose purpose, as set forth in its title, is "to adopt the weights and measures of the metric system as the standard weights and measures of the United States." This is the only bill dealing with the metric system which has received any consideration by a Congressional committee in recent years. It is very brief, its text being as follows:

"*Be it enacted, etc.*, That on and after January 1, 1905, all the Departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and on and after January 1, 1906, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States."

Quite a number of hearings on this bill have been accorded by the committee to persons interested in it, and attention has thus been freshly drawn to the subject. Although to many the discussion of the merits and demerits of the metric system has been worn threadbare, it may be well at this time to state them succinctly. The arguments in favor of the adoption of this system are few, but they are such as to appeal quite attractively to the general sentiment in favor of all possible simplicity and uniformity in commercial and business usages. They may be summed up as follows:

1. The decimal system, upon which the metric system of weights and measures is constructed, is much easier to memorize and compute than an arbitrary system such as that prevailing at present in the United States and Great Britain.

2. Assuming that uniformity throughout the world is a consideration worth

striving for, the metric system appears to be far more likely to secure universal adoption than the English system. The metric system is now the standard in practically every country but the United States, Great Britain, and the British colonies.

3. As the United States is now vigorously cultivating a foreign trade, the adoption of the metric system is urged as a matter of convenience in meeting the wishes of foreign customers and in attracting trade by conforming to foreign usages.

4. The trend of scientific usage all over the world is toward the metric system, including the centigrade method of measuring temperature. Scientific societies are rapidly growing international, and it is found that the metric system is the preferred method of recording such weights and measures as are employed in scientific treatises intended for international consideration.

The objections to the introduction of the metric system in this country are much more numerous, and, to a greater extent, are based on practical considerations. They may be summarized as follows:

1. No great popular demand appears to favor the adoption of the metric system. The movement in favor of it is confined almost entirely to those who are not actually engaged in business or commercial life.

2. Practical men, meaning those who are engaged in construction of any kind, are almost a unit against it.

3. Its adoption would sever the uniformity of our present system with that of Great Britain, with which country three-fourths of our foreign business is transacted.

4. Very great expense would be entailed in changing our measuring and weighing instruments and apparatus to conform to the metric system. It has been calculated that in a well-regulated machine shop, thoroughly prepared for doing miscellaneous work, employing 250 workmen, the cost of the new outfit adapted to the new measures would not be less than $150,000, or $600 per man.

5. The huge mass of English and American technical literature now in existence would be made almost useless after a generation or two. It would, perhaps, be necessary after that time to use a glossary or dictionary of obsolete terms to enable a student to comprehend this literature.

6. Land measures would be thrown into very great confusion, and future generations would undoubtedly have considerable difficulty in establishing titles.

7. Instead of simplifying our methods of weights and measures we would merely introduce another element which would for a long time add to the confusion which the advocates of the metric system claim now exists.

8. A large number of foreign words would be substituted for well-known English terms, which are so thoroughly understood and so constantly used that they are readily acquired by our youth.

Some of these objections are not very serious and could easily be dismissed, but others are so important that they would appear to be fatal to the hopes of those who are working for the adoption of the system. It might have been possible, say, forty years ago, when the United States was not such a great manufacturing nation, to make a change of this character. It could have been accomplished then at comparatively light expense. At that time, also, the country was not as thoroughly settled as at present, and there were great stretches of vacant public lands which are now under cultivation and occupied by agriculturists and ore miners, and dotted with cities and towns. Our land measures in the meantime have become more completely fastened on the country, while our manufacturing interests have grown so enormously that a change in measuring and weighing apparatus would be a matter of incalculable expense.

The growth in the use of the metric system among the nations of the world which do not rank as important manufacturing countries is hardly an argument in favor of its introduction here. It has been a comparatively easy matter to introduce the system in such countries. They have been largely importing manufactured products from other countries, and it has been a matter of convenience for them to adopt some system which would lend itself easily to international trade, as they could hardly use their own local weights and measures. The metric system was much more easily acquired than the English system would have been, and consequently it has made great headway in this respect. The world's progress toward uniformity is therefore less an indication of the merits of the metric system than it is a demonstration of the lack of that manufacturing progress leading to individuality in most of the countries in which it has been adopted.

The leading commercial argument advanced in favor of the metric system, which is the assistance it will render to the cultivation of foreign trade, has been shown to be of much less importance than would appear upon the surface. Our manufacturers have not experienced any serious difficulty in conforming, when necessary, to foreign methods. It has been found an easy matter for them to set forth the measurements required, according to the metric system, when necessary or desirable. It is, of course, much easier to do this for the small proportion of foreign trade handled than to change the system throughout an entire shop, when the great bulk of the products of the shop go into domestic consumption.

The statement is made by Chairman Southard, of the committee named, that this bill is not compulsory, but if that was not the intention of the author it is difficult to see why the phraseology used was adopted. It is true that it is not made specifically applicable to transactions between individuals, nor is a penalty definitely prescribed for the punishment of those who use some other system of weights and measures than the metric system. But it certainly compels all the departments of the Government to use the metric system after January 1, 1905, "except in completing the survey of public lands." This compels its use in a great deal of business in which the Government deals with individuals, such as contracts for public works, army and navy supplies and equipment, post-office supplies, Indian supplies, etc. Every manufacturer and every merchant dealing with the Government would be compelled to use the metric system, or his materials would not be accepted. Further, the provision that "on and after January 1, 1906, the weights and measures of the metric system shall be the legal standard weights and measures of and in the United States" comes as near being compulsory as words can make it. The enforcement of the law may be impracticable, but the intention is there.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, March 10, 1904.

Hon. James H. Southard, chairman, presiding.

STATEMENT OF MR. L. D. BURLINGAME, OF THE BROWN & SHARPE MANUFACTURING COMPANY, OF PROVIDENCE, R. I.

Mr. BURLINGAME. Mr. Chairman and gentlemen, I represent the Brown & Sharpe Manufacturing Company, of Providence, R. I. Our firm is engaged in the manufacture of machine tools, cutters, gears, scales, measuring instruments, and other instruments of precision. We employ in the neighborhood of 2,500 men, and do a large foreign business, both in England and on the continent of Europe. I have been with the company for upward of twenty years, and am familiar with their needs in many respects, occupying the position of chief draftsman of the company for the last fifteen years.

I also represent the Providence Association of Mechanical Engineers. This association has upwards of 150 members, who are representative of the machinery interests of Rhode Island, both the owners, the mechanical engineers, and managers in that line of business. I come to point out some ways in which the adoption of the metric system by a law such as is before us for consideration would be objectionable from the standpoint of these machinery manufacturers, mechanical engineers, and draftsmen, and therefore objectionable and detrimental rather than helpful to us.

I shall confine my remarks to the discussion of the question of linear measures, as that is a part of the bill which most directly affects our business. I will not go into the general arguments that

have been so extensively discussed before your committee, unless called upon to do so, but simply state that in the matter of subdivisions the metric system is not as convenient as the binary system, which we have at present. I would also state that the metric system contains no unit as convenient for our line of work as the inch. The millimeter, commonly used, is so small a unit that its value must be usually expressed in large figures, so that what we would now call 30 inches would become about 760 millimeters, and would be less convenient to handle and really require more figuring than our present system. In the matter of figuring drawings we have had considerable experience with the metric system in our dealings with foreign countries, and in comparing a large number of drawings we find the English system, with its fractions or decimals, is fully as simple and requires fewer figures than the metric system.

The CHAIRMAN. You speak of 760 millimeters; would you not in time come to express that in an even number of centimeters?

Mr. BURLINGAME. Seventy-six centimeters, say?

The CHAIRMAN. Or 7 decimeters?

Mr. BURLINGAME. That might be so, but, at the same time, if the millimeter is the unit which is used in calculation, the same as the inch is with us, we would naturally speak in terms of the millimeter; and I notice, as a matter of fact, the foreign machinery manufacturers do that. In comparing drawings from foreign concerns I find that they do figure it as 760 millimeters, not as centimeters.

The CHAIRMAN. The advantage of a decimal system is that when you have a quantity or measurement or weight expressed by units of one denomination you have it in units of every other?

Mr. BURLINGAME. In our work that does not count as an advantage, because in linear measure we now work decimally from the inch if we choose. In going above the inch we speak of 30 inches or 40 inches, or whatever the number of inches may be, and find it more convenient and better to do that, not but that we could use feet and inches if we chose.

The CHAIRMAN. Do you not have one instrument that measures the ten-thousandths of an inch?

Mr. BURLINGAME. Yes; and that is arranged decimally, too. Thirty or 40 or 100 inches is our method of expressing values above the inch. We do not use the foot. Our system is fuly decimal, as it is at present, if we choose to make it so.

Mr. LANNING. I understand your argument on this particular point is that you can adopt either the binary system or the decimal system by using the inch as the standard?

Mr. BURLINGAME. That is exactly the point, and, as a matter of fact, we do that.

Mr. LANNING. Can not you use either the binary system or decimal system when you have the metric system?

Mr. BURLINGAME. It might be we could, but where would be the gain? I see no gain in doing it. I simply state it is no better. So far as the matter of calculation is concerned, there has bee na good deal said.

I have made an effort for several months, and I have also, through our mechanical engineers and men who are doing our calculating, sought to find some problem where there would be a saving in our line

of work. I failed to find the first problem. Perhaps some of those who have used the metric system quite extensively could show us something, but among our foreign draftsmen, who have been brought up on the metric system, none of them have been able to show us any problem that has come up in our practical work where there would be the least saving by using the metric system. We are already on the decimal system so far as our work is concerned. These points, as I have brought them out, would lead me to the conclusion, and my own judgment would be, that for our work the metric system would be no better, in fact not as good as the present system. That is, considered on its merits, and taking into consideration the arguments brought up in favor of the metric system, that of a universal or international system, and arguments in favor of a decimal system, in favor of reduction of time in our schools and school work and in favor of our foreign trade.

Taking into consideration all these arguments, my own personal feeling and the feeling of our company is that the metric system would be no better than our present system. This is based on facts which I will bring out later in the discussion, and is entirely aside from the question of the great losses that there would be to us in making the change. That there would be such losses of a serious nature and extending for generations to come I will now show by some illustrations, aside from those that have been made most prominent before the committee, such as the screw threads and line shafting, and subjects of that sort.

The first thing that appeals to me is the question of our cutters. I have here several catalogues that I would be pleased to pass around to the members of the committee so that you can see more fully what I have in mind to say regarding them. These cutters have standard sizes of holes according to the English system, and they are for use in milling machines and gear-cutting machines, and other machines of that character that have been made by our company for the last half century. We can make cutters and send them to distant parts of the country and send them abroad and they will fit on any machine we have built since the establishment of our business. These cutters will fit on other makes of machines as well as our own. You will notice that almost all of the cutters have either a hole or taper shank. The size of the hole of the cutter must be standard in order to fit.

Now, let us consider what it would mean if we changed these to metric sizes. We would have a possibility of doing one of two things, either to express these sizes we now have in metric equivalents, in which case they would come in odd decimals, and our seven-eighths inch would be 22.225 millimeters, 1 inch would be 25.40, and so on. The other proposition would be to change them to the metric sizes which are used abroad. Now, these metric sizes used abroad and in such cutters as we make for the foreign market, where they insist on having a metric hole, are 22 millimeters, 27 millimeters, 32 millimeters, 40 millimeters, and 45 millimeters in diameter. You will notice they are not consistent. We would either have to adopt those inconsistent sizes in common use abroad, or else we would have to establish new sizes, which would be starting all over again. In either case we would feel it to be a very

serious objection. We would have to abandon our uniform sizes. We have now sizes that are consistent, being seven-eighths inch, 1 inch, 1¼ inches, 1½ inches, and 1¾ inches.

The CHAIRMAN. Let me ask you whether any action has been taken by any association to standardize these sizes.

Mr. BURLINGAME. I do not know that there has. It has been settled by the needs of the work, and I have no doubt that the foreign sizes were established as a copy of our English sizes, and by shifting one way and the other to adapt to their system makes them inconsistent.

The CHAIRMAN. I was not speaking of the foreign work; I was speaking of the work in this country generally. Has anything been done by manufacturers to standardize the sizes of the cutters that you are making and that other manufacturers in this country are making?

Mr. BURLINGAME. No; but as an explanation of that I will say that these sizes would naturally suggest themselves to all makers, and they are the universal standards throughout the English-speaking countries, and quite largely in foreign countries.

Mr. CANDLER. Other manufacturers in the same kind of business in which your company is engaged use the same sizes?

Mr. BURLINGAME. They do.

Mr. CANDLER. Universally?

Mr. BURLINGAME. Our cutters will go on any machine made by any other manufacturer here or in England, and their cutters will go on our machines. They are used in the Government Departments at present.

Mr. HEDGE. I do not want to interrupt too much, but did I not understand you to say that you make cutters at millimeter gauge for foreign use?

Mr. BURLINGAME. We do make such cutters, and you will find them in this catalogue you have. They are more particularly the gear cutters, and I will speak of them when considering the matter of the gear system, which is a very important one with us.

Mr. HEDGE. Why can't you just as easily make all your cutters on that millimeter standard?

Mr. BURLINGAME. As far as the actual manufacture of the cutter is concerned, we could, but as far as they are used in machines some of which have been in use for half a century by ourselves and our customers we could not. We have many thousands of cutters in our own works. If we had the metric system in use in our works all of the spindles and arbors of our machines would be unavailable—that is, the cutters would not fit on them, so it would be necessary to make such changes as would make them fit.

The CHAIRMAN. Why would not the cutter fit on them?

Mr. BURLINGAME. The cutters with metric hole would not fit on any English arbors or spindles.

The CHAIRMAN. If you change the size of the hole, you mean? What would be the necessity for that?

Mr. BURLINGAME. The reason for changing would be that these holes, as you see them on this list specified by English dimension, would become 22.225 millimeters, etc.

Mr. HEDGE. As an equivalent of what?

Mr. BURLINGAME. Seven-eighths of an inch.

The CHAIRMAN. In other words, the expression of the metric equivalent would not be as convenient?

Mr. BURLINGAME. Much less convenient; that would not be a thing that we would feel like perpetuating.

The CHAIRMAN. You mean this, it would cause some inconvenience but not necessarily any expense?

Mr. BURLINGAME. It would cause some inconvenience, and it would cause an eventual expense of making the change, because we would not consider it was a practical thing to perpetuate.

The CHAIRMAN. When that machine was worn out and had to be replaced, if a metric machine was in demand, really your expense would not be very much?

Mr. BURLINGAME. That would not cover the case, as I understand, because the same customer who has a machine with an English spindle would want to have the cutter fit on all the machines he has. He has an equipment of perhaps 50 machines in his shop; he buys a new machine from us which we furnish with metric arbor, and he has to have two sets of cutters, he has to double up on his set right there.

The CHAIRMAN. You mean you would have to manufacture for him?

Mr. BURLINGAME. Yes.

The CHAIRMAN. But this change would come very gradually.

Mr. BURLINGAME. I think it would, very gradually. It is going to cost just the same whether it comes gradually or not. It is going to cause the same confusion. It is not only two kinds of cutters that we would have to consider, but you would have to consider an English cutter with the English hole that we have now. The English cutter with metric hole you will now find on page 59 of this circular where this is given. You will find the metric cutter is furnished with a twenty-two millimeter hole or a seven-eighths inch hole.

The CHAIRMAN. Then, in fact, you manufacture all those things now?

Mr. BURLINGAME. Yes; but that is not just the point I am getting at; even though we manufacture them, a user of a machine can not use both kinds on his machine.

Mr. HEDGE. Who does use those?

Mr. BURLINGAME. They are used abroad in the main.

Mr. HEDGE. In England?

Mr. BURLINGAME. No; on the Continent.

The CHAIRMAN. Do you manufacture twist drills?

Mr. BURLINGAME. We manufacture cutters for making twist drills.

The CHAIRMAN. You make twist drills in metric sizes?

Mr. BURLINGAME. The cutters would make them in either system. Only if the cutters we have in the English system were changed it would mean that the machines on which those cutters were used would have to be changed to suit the new sizes of holes in the cutters.

The next point I had in mind to speak of was the matter of our gear system, based on the inch, a system so extensively in use that millions of gears are cut every year in this country based upon it, gears that are interchangeable. We carry a large stock of these gears in our works, as shown by this little catalogue I have just

handed to you, and they are so made that we can furnish them to any part of the country. Now gears can be made to run with gears that have already been used on machines built many years ago. The system has remained constant. It is the English and American method. Now, the metric system of gears is not interchangeable with the English system. That system is what we call the module system. While I will not go into the technicalities of the matter, I will simply state that our system is based on the number of teeth per inch of diameter, while the module system, the foreign system, is the number of millimeters of diameter for each tooth in the gear. You will find illustrations of gears in this little pamphlet that show what I refer to.

The CHAIRMAN. Where?

Mr. BURLINGAME. On page 13. There is a section through a gear; on page 55 there is a pair of bevel gears illustrated; and on page 58 a combination of gears such as are used for motor carriages; on page 69 a model showing various forms of gears in use; and further along, on pages 72 and 73, the shape of the gear teeth is indicated.

The CHAIRMAN. Please repeat, if you will, why it is the module system and your system are not interchangeable, and can not be made interchangeable?

Mr. BURLINGAME. The module system is based on the number of millimeters of diameter for each tooth; the English system is based on the diametral pitch or number of teeth for each inch of diameter. It works from a different standpoint entirely, so that if you express an English size in metric you will get a long decimal fraction. Possibly we have here something which will illustrate that point.

Now, refer to page 58 of the first circular I handed you. There you will see "Pitches commonly used. Module in millimeters." You will notice there a module given as 1.25 millimeters, 1.5 millimeters, and then you will see the corresponding English diametral pitch against it. It becomes quite decimal. The 1.5 module becomes 16.933 diametral pitch, which would be very awkward and expensive in calculating; that is, supposing we keep our present system and simply express it in metric equivalents. Here are some blueprints that will illustrate in part what I mean, and I will hand them around so that you can see.

Mr. LANNING. You just stated that the module system and the English system are not interchangeable. As I understand you now, in the light of what you have just said, you mean that practically they are not interchangeable, but theoretically, in figures, they can be?

Mr. BURLINGAME. Practically they are not interchangeable, because gears cut with the two kinds of cutters will not run together.

The CHAIRMAN. But the matter is one of calculation?

Mr. BURLINGAME. The matter is one of calculation, largely.

The CHAIRMAN. Then, in fact, they are interchangeable?

Mr. BURLINGAME. They are interchangeable, if you will go to the trouble of the complicated calculation which is necessary to transfer one into the other.

Mr. SMITH. But you do away with the small figures and introduce large ones?

Mr. BURLINGAME. Introduce very much larger ones, and introduce a system which we would never tolerate as a permanent thing. Now, this blueprint that I have handed you illustrates that point in answering in part the very question you ask. You will see there a pair of gears

drawn, and they are marked 6⅝-inch center distance, 8 pitch. That is as we would make them. This I took from one of our drawings before I came away. The problem would become with us, if we had to change to use either a 3 or a 3.5 millimeter module cutter, which I have marked above and below—you will see, if we made it 3-millimeter module, the center distance would be reduced quite materially; if we made it 3½, it would be increased.

Mr. LANNING. Go over that again.

Mr. BURLINGAME. In this blueprint or diagram you have before you you will find near the middle a figure of 6⅝ inches, center distance, between two centers of the gears and against it is marked 8 pitch.

Mr. HEDGE. What does that mean?

Mr. BURLINGAME. That means the diametral pitch of our present system.

Mr. HEDGE. What does that mean?

Mr. BURLINGAME. Eight teeth to every inch of diameter of the gear. It is a simple rule that we have used for a great many years. Now, we change to the metric system and our draftsman is confronted with one of three things—either to call that an odd-metric module and leave the center distance as it is and make his calculation accordingly, or to change to a 3-millimeter module, as shown above, where it is marked 159 millimeters center distance, or 185.5 millimeters center distance if made 3.5 millimeters module. Then it becomes with the draftsman a problem to decide whether he will decrease the center distance to the inner line or increase it to the outer line in order to make a pair of gears using cutters on the metric system that will run. In either case he must change his tools and drawings. The only alternative is to express it in the awkward equivalent which we have spoken of as being very inconvenient for us. Now, the cutters for making these gears are in sets. That little book I first handed you would show that. There are eight cutters in a set for each pitch, and it involves a great investment for a company to get cutters to cover the needs of the business. We have something like 3,000 gear cutters in our works, which would be useless if we changed to a metric basis. Those cutters do not wear out rapidly; they are used for a great many years, and it would involve a direct loss as far as we made the real change, and serious inconvenience as far as we used the equivalents. Thus I claim that the systems are practically not interchangeable.

Mr. CANDLER. Could you estimate that loss?

Mr. BURLINGAME. It would be a loss of several dollars for each cutter. We have 3,000 gear cutters in that one department.

Mr. SMITH. All the Government machine shops are fitted with the same machines?

Mr. BURLINGAME. They are, as I understand it. Now, the term "hob" is applied to a cutter for cutting worm wheels. Here is a photograph of a pair we recently made. Those cost $275 for the pair [indicating]. You will find in the back part of this handbook of gears, on pages 88 and 89, a list of hobs. You will see there is a long list, following from that page, of hobs we have on hand, all based on the threads or turns per inch, which is our present system, and we have upward of 500 of these hobs now on hand in our works, valued at an average of $25 each, which are used for hobbing wheels for

customers, and which, as you see, we advertise here. That would involve a direct loss to us if our customers commenced to order in metric system. Those hobs are a permanent investment with us, and will be in use from fifty to one hundred years from now in most cases. There is no reason why they should wear out during that time, and so far as they are laid one side by a change in the system it would be a dead loss to us.

The CHAIRMAN. You have them in metric sizes now?

Mr. BURLINGAME. We have not in our regular system. We have made hobs in metric sizes for our customers, but in our regular system, which is advertised in this book, we have only the English sizes.

The CHAIRMAN. If you have any work involving metric dimensions, you make them?

Mr. BURLINGAME. We do; yes, sir. It is a matter of business with us; a matter of dollars and cents, of course.

The CHAIRMAN. As a matter of fact, there is no machine that could be ordered in your line that you could not make if you got an order for it?

Mr. BURLINGAME. That is probably true. It is not as true with our business as it is with some, because we make a specialty of certain lines and try to keep within those lines, and do not take outside work except to satisfy our customers by adapting their work to our machines.

The CHAIRMAN. We used to hear of twist drills a good deal. The Morse twist drill was not made in metric sizes? It is now made in metric sizes?

Mr. BURLINGAME. There is no reason why it could not be.

Mr. SMITH. They do make some in metric sizes, but the taper shanks are not changed.

Mr. BURLINGAME. Of course, we would not consider changing these shanks of our twist drill. They are fixed, and must stay so, regardless of what equivalent we use.

Now, I wish to emphasize the fact that these systems I have spoken of are far-reaching and affect our work vitally for both us and our customers; that they are not easily translated from one system into the other, and that they are not easy to express in equivalents in one system or in the other. And I would also emphasize the fact that, supposing the Government adopted the metric system for its Departments and continued to order machines from us, as they are doing constantly, then, if they begin ordering cutters in the metric system, as the law would require, and if they have their shops equipped in the metric system, when it comes to replacing or recutting gears or to doing work that would use our cutters and our gears there would be the mix-up, in that the Government would have to have its work done specially.

Any new concern just starting up on the metric basis would have constant confusion in getting its work, sometimes in one system and sometimes another; while old, established concerns like our own would continue in the old way because we would find it difficult to change in many things and we could not change in others. It would be a long time before the change could be effected.

The CHAIRMAN. You have that same mix up to-day, have you not?

Mr. BURLINGAME. We have not, because our work is practically all made on the American and English basis of the inch.

The CHAIRMAN. I understand you have orders for tools and cutters in metric sizes.

Mr. BURLINGAME. We do; but that does not involve a loss of standards or trouble inherent in the internal working of any particular shop.

Mr. LANNING. When you get such orders, they are, as I understand you, from foreign countries, where the basis used is the metric system?

Mr. BURLINGAME. Yes; so that each shop in itself is consistent.

Mr. LANNING. And also you get your orders in figures expressed in the decimal system, that are convenient to work with, and not figures that run into long decimals?

Mr. BURLINGAME. That is my understanding of it.

The CHAIRMAN. Now let me ask you: England is quite a machinery-manufacturing country; why is it that there seems to be such an agitation and tendency toward a decimal system there?

Mr. BURLINGAME. I have heard considerable of the agitation.

The CHAIRMAN. I have an article here from the London Times of February 24, and I understand they have at the Department a communication from the Decimal Association saying that they have an assurance that a majority of the Parliament is ready to make the metric system compulsory over there; and I have a long article here in the London Times in which are expressions by the Marquis of Lansdowne, the Earl of Roseberry, the Duke of Rutland, Lord Tweedmouth, Lord Wolverton, and others——

Mr. SMITH. I think it is in that class, Mr. Southard; I do not think the manufacturers want it.

The CHAIRMAN. All I know is what I get from their expressions.

Mr. SMITH. I have been reading about that. I know there has been a good deal of agitation in Parliament for this metric system, but it does not come from the practical people.

Mr. BURLINGAME. What is useful for science is sometimes not useful for practical manufacturers.

The CHAIRMAN. They speak of it as being beneficial to the trade, that it would be beneficial to the industrial interests of Great Britain; that is the line along which the argument proceeds from these men—that it would be beneficial to the industrial interests of the country to adopt the metric system; that there is loss to the country by reason of their system not conforming to the system of the Continent and the world. They all speak very strongly in favor of the metric system.

Mr. BURLINGAME. Any adoption by England of the metric system would be a serious detriment to us. We have a large trade there that would be affected by it, and it would cause us much trouble.

The CHAIRMAN. For instance—let me interrupt you just a moment—it starts in with:

Lord Belhaven, in moving the second reading of this bill for rendering compulsory the use of the system of weights and measures commonly known as the metric system, said that the question affected every person in the United Kingdom. He should have been glad to leave the subject to the Government, but judging by their answers to deputations they apparently held the view that public opinion was not yet formed sufficiently in favor of the metric system to make it compulsory. His opinion, however, was that a strong public opinion favored this bill, especially among the commercial classes.

And he goes on to speak of that select committee which in 1895 reported in favor of the adoption of the metric system, and a meeting of the colonial conference a year ago, in which they passed a——

Mr. BURLINGAME. Do I understand that the committee was largely a committee of scientists?

The CHAIRMAN. This was a matter up in the House of Lords, and they finally referred it to a select committee to report a better method and for its introduction, as I understand it.

Mr. LANNING. My recollection is, Mr. Chairman, that that committee was composed of scientists, and it has been charged they were theorists rather than practical men. I may be in error about that, but that is my impression.

The CHAIRMAN. I think not. That is not my recollection.

Mr. SMITH. That is mine. I have noticed that in England there was agitation of that very question.

Mr. CANDLER. It was stated by some witness here some time ago that they were theorists; scientists, instead of practical men.

Mr. SMITH. It would be doubtful, indeed, if iron and steel manufactures in England would for an instant recommend that. I am very certain they would not.

Mr. BURLINGAME. I have here a book of the screws and stock parts that are made by our company. There are four thousand kinds of parts represented in these books. We carry a million and a half of these pieces in stock all the time. That is the only copy I have, and it may be passed around if it is of interest. The sizes and dimensions are all there in even English dimensions, and are of such a character that by a moment's study any one of you would see something of what it would mean for us to change or express in metric equivalents. It is simply one of the troubles we would meet with at once when we came to seriously consider making a change. This has been worked up during the last fifteen or twenty years with us, and it is a vital part of our system.

In the manufacture of sewing machines there are a great many small pieces. Here is a small piece I selected [exhibiting] and brought with me. It is a part of what we call the lock-stitch sewing machine. I wish to show some photograhs, too, showing the tools for making it. It seems hard for us to believe, even for those of us who are in the business, that it would take $600 worth of tools to manufacture that piece. This photograph [exhibiting] shows the tools. That piece is illustrated with a red circle around it at the top of the photograph, and there are 14 mechanical operations and 4 hand operations, making a total of 18 operations on that piece.

Mr. LANNING. In order to identify this photograph, I would judge it should be marked "Burlingame, No. 1" so that we know what it refers to.

Mr. BURLINGAME. That set of tools is valued at something like $600, for making that one piece, and I simply bring it to show what refinements we have to go into in the manufacturing of parts. The number of parts in that same sewing machine are shown by this pamphlet [exhibiting], each having its own set of tools. The photograph shows every tool stamped with its size in decimals of an inch, and if we expressed those dimensions in metric equivalents, or if we changed them, in either case it would mean a serious change for us. Here is a list of operations on that one piece.

The CHAIRMAN. There would really be no occasion to do either in this matter, would there?

Mr. BURLINGAME. There would if we were to change our shop to the metric system.

The CHAIRMAN. There is a great big "if" in there?

Mr. BURLINGAME. There would be with us, because we would not feel as if we were justified in changing.

The CHAIRMAN. Suppose the Government went into the use of metric weights and measures, what would be the use of changing a thing in this machine? What would be the necessity of changing one single part that you have photographed here?

Mr. BURLINGAME. The object of the Government's using the metric system would be to extend its adoption to the whole country.

The CHAIRMAN. What would be the occasion of changing one single part?

Mr. BURLINGAME. I say, from our standpoint, we would not consider it was necessary or desirable.

The CHAIRMAN. Then, if it was not necessary to change a single part, you would not be put to one cent of expense?

Mr. BURLINGAME. Not if we retained our English measure.

The CHAIRMAN. I am supposing now that the Government passes to the use of metric weights and measures; what is there about that that would occasion you one particle of inconvenience or expense so far as changing one tool that has been photographed?

Mr. BURLINGAME. That is, you would consider we would not have to express the values in metric equivalents?

The CHAIRMAN. Why would you? You would make that same machine just as you did before?

Mr. BURLINGAME. We would. But suppose that fifty years from now we were making it——

The CHAIRMAN. I am not supposing fifty years, I am speaking of the present.

Mr. BURLINGAME. We have to consider the future of what we are making now.

The CHAIRMAN. You are anticipating what would happen in fifty years.

Mr. BURLINGAME. We would have to do that in considering our business; ten years or fifty years—it is immaterial—simply in the future. The day would have to come——

The CHAIRMAN. The machine may not be used at all in fifty years?

Mr. BURLINGAME. It might not.

The CHAIRMAN. The chances are it would be out of date.

Mr. BURLINGAME. The Wilcox & Gibbs sewing machine is still being made.

The CHAIRMAN. It is not the same machine?

Mr. BURLINGAME. The majority of the parts and tools are the same as they were when I commenced work for the company, and I have been twenty years with them, and they were in use many years before I started in.

The CHAIRMAN. Is it not a fact that almost all of those parts which now accompany sewing machines have been changed again and again during the last twenty or thirty years?

Mr. BURLINGAME. Many things have changed.

The CHAIRMAN. There is hardly a machine in which all of those small parts have not changed frequently.

Mr. BURLINGAME. At the same time, in the future, those machines would have to be repaired, even if a new design came out. The old sewing machines are in use and have to be repaired.

The CHAIRMAN. How many sewing machines do you think are in use now that are twenty years old?

Mr. BURLINGAME. I know of a number right in the range of my personal experience.

The CHAIRMAN. You can buy them for $4 apiece, can you not?

Mr. BURLINGAME. You can buy them very cheap second hand, but persons who have old machines use them. The thought is, that eventually we would have to express the dimensions of all the machines we build in metric equivalents, at least, if not to change the dimensions. Of course, you will not, or no one would, advocate changing the sizes of these sewing-machine tools. We would realize it would be an immense expense that could not be considered.

The CHAIRMAN. And one that would not be necessitated by any suggestion that has been made.

Mr. BURLINGAME. Eventually, if we got into using metric tools, we would have to have our shop made a metric shop, and we would have to have two sets of tools in use at the same time.

The CHAIRMAN. When you pick up a tool in the manufacture of a machine, do you make any note of the English or metric dimension of that tool?

Mr. BURLINGAME. Certainly. These examples I have here illustrate; we stamp the tool with the dimensions.

The CHAIRMAN. I have seen workmen use these tools, but I have never seen them with paper and pencil in their hands.

Mr. SMITH. Do you ever give workmen dimensions in the metric system, or do you translate them yourself?

Mr. BURLINGAME. We do it ourselves.

Mr. SMITH. No workman works in the metric system?

Mr. BURLINGAME. No. Doctor Stratton has called us down once or twice on that account. The workmen have the tools in the English measurement, and I will explain in a moment why we prefer to have them work with those tools rather than take the chances of using some tool with which they are not familiar. One thing more before I leave this matter of sewing-machine parts. Here is another photograph that shows a case that is more extreme [exhibiting]. The one I showed you is an average case. Here is another piece of the same sewing machine, just a bobbin case, that requires about $4,000 worth of tools.

The CHAIRMAN. Suppose the Government were to conclude to use metric weights and measures, what tool here would you change?

Mr. BURLINGAME. The argument would be the same as in the other case.

The CHAIRMAN. Answer my question, please. What tool would you change?

Mr. BURLINGAME. We would not change a tool.

The CHAIRMAN. No; I thought not.

Mr. BURLINGAME. We would not use millimeters; we would continue to use inches in our shop. I am speaking now in case the bill passed. That is the feeling of our company, that we would continue to use the inches and get along as best we could in translating for the work that came to us from outside, and put up with the

expense rather than have the greater expense of putting our workmen on the metric basis.

The CHAIRMAN. What sewing machine does this represent?

Mr. BURLINGAME. It belongs to the lock-stitch sewing machine.

The CHAIRMAN. Would it be incumbent upon the lock-stitch sewing machine to change anything?

Mr. BURLINGAME. No more in other parts than in these details.

The CHAIRMAN. What would necessitate the change of these details?

Mr. BURLINGAME. I would say that if our shop went on the system of measuring with metric tools, that would change every figure that is stamped on those tools to the metric equivalent.

The CHAIRMAN. I would like to ask you a specific question and get a specific answer, if I can. Suppose the Government concluded to use metric weights and measures, what tools are there that you have exhibited here that it would become necessary to change in any respect because of that determination by the Government?

Mr. BURLINGAME. There would be no tool whatever, so far as that specific question you ask is concerned.

The CHAIRMAN. If there was no change, there would be no expense.

Mr. SMITH. Would there not be, in cutters?

Mr. BURLINGAME. I am now speaking of the matter of the sewing-machine parts only.

The CHAIRMAN. Are you not anticipating something that will never happen?

Mr. BURLINGAME. I think I am, because I do not think the country will change.

The CHAIRMAN. Even if it did change?

Mr. BURLINGAME. I should say no, in that case.

The CHAIRMAN. It may happen fifty years from now.

Mr. BURLINGAME. It will certainly be as long as that, in my judgment. I am speaking of the mechanical trades. I am not speaking of buying eggs and groceries, and all that. I am speaking of the mechanical interests, and what is tied up and affected by them. I am trying to hold myself strictly to that.

The CHAIRMAN. You are trying to tell us what enormous expense and inconvenience the passage of this bill would entail?

Mr. BURLINGAME. Yes; if the country took it in the spirit in which it is meant and tried to live up to it.

The CHAIRMAN. In what spirit is it meant?

Mr. BURLINGAME. It is the starting point for the general adoption of the metric system—an entering wedge.

The CHAIRMAN. Well, suppose that the Government has adopted the metric system, and it has come into general use; now, what inconvenience or expense would be entailed, so far as manufacturing that machine is concerned?

Mr. BURLINGAME. Our workmen would then be working in millimeters, and would wish to express in millimeters the value of those dimensions. The draftsman and mechanical engineer, who have charge of this sewing-machine work, and all workmen connected with it, would wish to express in millimeters those values. We would not then change the dimensions; that we would feel we could not possibly consider, but we would want to express them in metric equivalents, and I have been trying to point out in this particular illustration how

great a trouble it would be to even change to metric equivalents, to say nothing of changing the dimensions of the machines.

The CHAIRMAN. You say you would wish to express them in metric dimensions?

Mr. BURLINGAME. If our shop became a metric shop.

The CHAIRMAN. Still that would not be necessary?

Mr. BURLINGAME. It would not be necessary——

The CHAIRMAN. So that, as far as anything you have shown is concerned, it would not be necessary to go to a particle of trouble or expense so far as the reproduction of that machine is concerned?

Mr. BURLINGAME. I will simply reiterate what I said before, that if our shop in its internal work used the metric system we would be put to expense and trouble in this instance I have cited.

The CHAIRMAN. Suppose we were to go immediately to the metric system, will you please tell me what expense and trouble it would occasion to anybody who wanted to reproduce that machine and put it on the market—I mean the sewing machine?

Mr. BURLINGAME. The expense and trouble would be in expressing in metric equivalents or values besides those of the inch which are now used.

The CHAIRMAN. Why would it be necessary to express those in metric measurements?

Mr. BURLINGAME. Because our shops would be using the metric terms, and we would wish to have it on one basis. I might, perhaps, speak of my next point now as a practical answer to your question. I have here the tools which every mechanic uses, from the apprentice boy up to the tool makers, and I want to show them to you, not as fine precision tools, but everyday tools.

The CHAIRMAN. You say that you would wish to do it. It would merely be a matter of desire and not of necessity, would it not?

Mr. BURLINGAME. Let me use an illustration. The man who has this micrometer [exhibiting] would have to change it for a micrometer expressed in millimeters.

The CHAIRMAN. Why?

Mr. BURLINGAME. Because he would want to measure in millimeters, if that was the system used in our shop. And for that reason he would wish to have——

The CHAIRMAN. Why would he want it? He has already got his micrometer?

Mr. BURLINGAME. His micrometer will not read values in millimeters.

The CHAIRMAN. Why would it be necessary?

Mr. BURLINGAME. Because all those sizes have to be verified, and tools have to be——

The CHAIRMAN. Why can you not make it with the same tools you have on hand?

Mr. BURLINGAME. Those tools are all stamped with the English sizes.

The CHAIRMAN. Why not leave them stamped with the English sizes?

Mr. BURLINGAME. Then we would not be working on the metric system?

The CHAIRMAN. I am not talking about your working with metric tools; I am talking about your building this machine.

Mr. BURLINGAME. If you will look on the photograph you will see there are almost endless tools that would have to be made over and reproduced as they wore or were broken.

The CHAIRMAN. You could reproduce those tools?

Mr. BURLINGAME. Then we would want the metric sizes because the men in the shop would be using metric tools.

The CHAIRMAN. So long as you continue to make that machine, why not use the same tools?

Mr. BURLINGAME. Then we would have to keep the present micrometors and other tools in use for that purpose, and have two sets going in the shop for generations to come.

The CHAIRMAN. As far as the reproduction of this particular machine is concerned, there would be no extra expense or trouble?

Mr. BURLINGAME. There would be in the sense I have just explained.

Mr. SMITH. You can not use this [exhibiting a micrometer caliper] in connection with the metric system?

Mr. BURLINGAME. No; we could not.

Mr. SMITH. How many thousands of those do you suppose are in use in the country?

Mr. BURLINGAME. We sell many thousand a year, and have made them for years.

Mr. SMITH. What proportion of your work have you ever done by the metric system?

Mr. BURLINGAME. It would be a very small fraction of 1 per cent.

Mr. SMITH. Less than 1 per cent, would it not?

Mr. BURLINGAME. Very much less.

Mr. CHANDLER. Do you know of any benefit that would be derived from the change?

Mr. BURLINGAME. As far as the mechanical industries are concerned, I do not know any whatever.

Mr. CANDLER. Is there a universal demand?

Mr. BURLINGAME. Among our foremen and mechanical engineers there is a strong feeling against it.

Mr. CANDLER. Are not these measurements and this system used universally among all English-speaking people at this time?

The CHAIRMAN. We know that is not true, universally.

Mr. BURLINGAME. There are those who recommend that if the metric system is adopted the old standard be retained for land measure and in mechanical work for screw threads, gear systems, and in other places where the difficulties of changing would be greatest.

Let me ask the advocates of such a plan how they expect to make the great saving in school training if the old system must still be learned? There would certainly not be the simplicity claimed if we should have two systems instead of one.

If, on the other hand, they expect eventually to do away entirely with the present system, is not this plan like that of pulling a tooth out gradually, so as not to hurt as much?

Those that advocate a change at this time, by the Government only, will later ask for another step, and so on until they will ask for compulsory legislation in the end. Their policy reminds me of a story

told by the late confederate, General Gordon. While making his cavalry raid into Pennsylvania he gave strict orders not to injure private property. His men were greatly in need of firewood and asked permission to use the fences. He told them they might take the top rail. In the morning the fences had entirely disappeared, and he called the men to account. Every man swore, however, he had taken only the top rail.

Your chairman, Mr. Southard, in his report to Congress two years ago very truly says:

> In no other country has the construction of machinery reached a degree of perfection superior to that of our own—a result principally due to the system of interchangeable parts. The latter may be said to be a product of American ingenuity and to be the greatest single advance in modern machinery. It has for its essential features a uniform standard of length and accurate length-measuring instruments. This work has been done upon the basis of the inch.

Nothing has done more to build up the industries of our country than our mechanical development and that has, as just quoted, been based on our system of interchangeable parts.

It being true that we already lead in the standardizing of our work and that it is interchangeable for so many years back, why should we sacrifice the advantage we now have and start back at the beginning with so serious a handicap?

Is it any wonder that our competitors abroad are anxious we should do so?

In the illustrations I have used—the interchangeable cutters, the gear system and "hobs," the screws, and stock parts—I simply touch on what such a change would mean to us and our customers. What applies to us applies to others in our line of business.

When an opportunity was given last year for the members of the American Society of Mechanical Engineers to express themselves on this question they did so, opposing a change.

I would again emphasize the fact that it is not alone the first cost of changing standards and gauges that is the greatest objection. This, though important, is insignificant compared with the greater evil of breaking away from our standards and interchangeable system.

It surprises me to know that experienced men have expressed themselves before this committee to the effect that a change could be made in one or two years or even less. I can assure you that, as representing machine-tool manufacturers, a generation, yes, a hundred years, would not see the change completed.

Our mechanical industries, based on the present linear measures, are "irrevocably tied to the past." I quote these words from a letter to this committee from Mr. H. D. Sharpe. This letter was published with the testimony at last year's hearing, and I most earnestly urge your further consideration of the important arguments contained in it bearing on this subject.

It is not because of our conservatism or sluggishness that we are tied to the past, but because of our rapid progress and our advancement beyond all other nations of the world in standardizing mechanical work.

We are in a position to be leaders not followers.

Thereupon, the committee adjourned.

PROVIDENCE ASSOCIATION OF MECHANICAL ENGINEERS,
Providence, R. I., February 29, 1904.

Hon. JAMES H. SOUTHARD,
Chairman of the Committee on Coinage,
Weights and Measures of the House of Representatives,
Washington, D. C.

At a regular meeting of the Providence Association of Mechanical Engineers, held on the evening of February 23, 1904, the following resolution was unanimously adopted:

Voted, That Ex-President L. D. Burlingame be authorized to present to the Congressional Committee on Coinage, Weights, and Measures the resolutions recently passed by this association in opposition to the adoption of the metric system.

The resolutions are as follows:

"Whereas renewed attempts are being made to bring about the adoption of the metric system of weights and measures, through its enforced use in the Departments of the Federal Government;

"Whereas we regard a change in the system of weights and measures used by the people at large to be practically impossible, thus making a change by the Government alone uncalled for; therefore be it

"*Resolved by the Providence Associatioin of Mechanical Engineers*, That we condemn this law as one that will introduce further diversity and confusion, especially as affecting linear measure.

"*Resolved*, That we regard the proposed legislative action affecting our established system of weights and measures as unwise."

Yours, truly,

MARION C. HAPPOLDT, *Secretary.*

FEBRUARY 27, 1904.

The COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
House of Representatives, Washington, D. C.

GENTLEMEN: In a letter of February 15, addressed to Mr. Henry D. Sharpe, of the Browne & Sharpe Manufacturing Company, Mr. Southard, after speaking of the hearings of his committee on the metric bill, closes as follows:

"I am utterly at a loss to see how the adoption of the metric weights and measures by the Departments of the General Government would seriously affect you one way or the other."

Mr. Southard, by this sentence, confessedly shows his lack of appreciation of the fact that the adoption of the metric system in all the Departments of the Government can have but one purpose—and that the eventual adoption of that system by the whole country.

If, however, by any form of reasoning, we could be convinced that the purpose of this legislation is to confine the metric system to the Government alone and the discussion were narrowed down to that basis, we should still feel that we were "seriously affected" by it and use our influence against it for two reasons.

First. Someone is going to pay the bills for the great expense entailed, and while it is natural that every business man will try to take it out of the consumer, the people must in the last analysis pay the bills for the expense and confusion attending the change in the Departments of the Government; great expense and long-continued confusion, especially in the mechanical departments. This would involve loss, which, from our practical experience and the experience of others, with the details of such work, we feel has been greatly underestimated.

Second. The delay, annoyance, and misunderstandings in all dealings between the Government and the manufacturers, reaching the point of serious financial loss to the latter when a strict interpretation is placed on this law by Departments of the Government. Certainly every manufacturer doing business with the Government either directly or indirectly would be "seriously affected" in one way or another.

While, in our opinion, the serious effect is going to be on the Government primarily, we feel that the discussion can not be confined to the adoption by the Government alone, for the reason before stated. This is the prospect placed before us, not only of great engineering departments of the Government but also of great engineering establishments outside having imposed upon them this most impractical scheme, because some people imagine harmony is going to be

promoted thereby; instead, the many industries of the country are going to be affected by the sacrifice of their standards, and by having their language of measurement thrown into confusion.

We should never think of thrusting upon our own business such an incubus as is proposed by the metric bill, neither would we think of approving the measure as applied to the whole country. We believe the first to be consulted in a matter like this should be the users. Their voices should be the ones above all that should be heeded.

We have taken this matter up in good faith, hoping to help the committee by giving them the benefit of our judgment based on our practical experience.

What we would urge upon each member of this committee is to oppose this legislation which will "seriously affect" private business as well as the Departments of the Government.

BROWN & SHARPE MFG. CO.,
Providence, R. I.

Table comparing sizes of holes in cutters.

Metric sizes:	Present sizes:
22 millimeters = 0.866 inch.	$\frac{7}{8}$ inch = 22.225 millimeters.
27 millimeters = 1.063 inches.	1 inch = 25.40 millimeters.
32 millimeters = 1.260 inches.	1$\frac{1}{4}$ inches = 31.75 millimeters.
40 millimeters = 1.575 inches.	1$\frac{1}{2}$ inches = 38.10 millimeters.
45 millimeters = 1.772 inches.	1$\frac{3}{4}$ inches = 44.45 millimeters.

STATEMENT OF MR. WILFRED LEWIS, PRESIDENT THE TABOR MANUFACTURING COMPANY, OF PHILADELPHIA, PA.

Mr. LEWIS. I can not say that I am unalterably opposed to the metric system, having already voted in its favor as being possibly the lesser of two evils, but it has seemed to me that it had certain inherent defects which Mr. Smith has alluded to. I think the difficulty of continuous subdivision by 2 is the most important. That might possibly be overcome by a change of base, but I am not so sanguine as Mr. Smith that such a change could be effected in one or two generations. Now, it seems to me that the more civilized we become the more difficult such a change would be. If we could go backward to the time of the old Arabs the difficulty would be very much less. It is comparatively easy to learn a new thing, but it is immeasurably more difficult to unlearn what is already acquired.

I have always favored subdivision by 2 as being the most practical method for shop use, and the question with me is whether the theoretical advantages of a decimal system should give way to the practical advantages of the shop or whether the shop should adapt itself to the theoretical advantages of the decimal system. These theoretical advantages are obvious, but it is a matter for regret that our notation is founded on a base of 10 rather than on a base of 8 or 16, as Mr. Smith has suggested.

At one time I thought the theoretical advantages outweighed the practical considerations, but in these days of slide rules, when people are satisfied to figure within a tenth of 1 per cent and can do it at once mechanically, the use of decimals makes less difference than formerly, when multiplications and divisions were performed by mental labor. So I began to think that a system founded on the inch—and I see no reason why we should change it if our weights and measures were all correlated to it in a manner similar to the centimeter, the metric system—might meet with more favor and be

of more practical use than the metric system as it stands. That is the conclusion that I have more recently come to, although, as I say, I have voted in favor of the adoption of the metric system.

The CHAIRMAN. What would be the value of a universal system, if we had one?

Mr. LEWIS. I think a universal system is very desirable, in view of the fact that there is no system but the metric system to-day in use anywhere.

The CHAIRMAN. Do you think it is possible to have a universal system of weights and measures?

Mr. LEWIS. Yes; I think it is.

The CHAIRMAN. Then, if we are to have a universal system, I take it, you believe it will be the metric system?

Mr. LEWIS. I am not sure it will. I think it might be a system that would be better adapted to practical requirements than the metric system.

The CHAIRMAN. If it is any system that is now in use, it must be the metric system.

Mr. LEWIS. Yes, sir; because that is the only system in use; there is no other system.

Mr. HEDGE. I do not understand exactly.

The CHAIRMAN. Please explain the situation.

Mr. LEWIS. There is no other system than the metric system in which the measurements of length, volume, and weight are all correlated. They are not correlated in any other so-called system. Therefore there is no other system. Disjointed aggregations is all you can call anything we have in English to-day.

Mr. HEDGE. Everybody agrees on what an inch is?

Mr. LEWIS. Yes, sir.

The CHAIRMAN. No; I think not. Are there not different inches?

Mr. LEWIS. I believe there are different feet, and that would necessarily make different inches.

Mr. LANNING. As I understand Mr. Lewis's point, it is this: That the inch has no theoretical or scientific relation to the quart or the pound.

Mr. LEWIS. That is it.

The CHAIRMAN. But, as a matter of fact, we have numerous units in the world called an inch, varying in value?

Mr. LEWIS. Yes, sir.

Mr. BROWN. Is not the quart based upon so many inches of distilled water?

Mr. LEWIS. I do not know what you mean by a quart. There are two or three things called by the same name.

Mr. LANNING. Can you explain briefly what you referred to a little while ago when you said that sliding scale, as now used, saved mental labor?

Mr. LEWIS. Nearly all engineers make use of a slide rule for multiplication and division, and they are satisfied if they can obtain three significant figures which give results to one-tenth of 1 per cent Their fundamental data seldom are as close as that, and if they obtain a result which can be represented by three significant figures there is no use of going any further. The slide rule gives that. It can be made to go four figures.

Mr. LANNING. Can you give us a practical illustration of where

the sliding rule would be used to show us just how the mental labor would be saved?

Mr. LEWIS. I have a slide rule here. There is a scale here [indicating] running from one to ten, and from one to ten again. This is the same scale. It is graduated to the logarithms of the numbers which it represents, and multiplication, as we all know, can be performed by the addition of logarithms. If you set the unit mark here [indicating] to one number that you want to multiply and set this [indicating] to the other number, you read off the product on the the first line, or if you want to divide 550 by 275 you simply read off the result there [indicating]. If you want to divide 550 by 275 the answer is 2.

Mr. LANNING. That is very easily done mentally. Can you give us something not done so easily mentally?

Mr. LEWIS. Yes, sir.

Mr. LANNING. Suppose you divide 650 by 275.

Mr. LEWIS. That is 2.37, as near as I can read it.

Mr. LANNING. It is 2.37?

Mr. LEWIS. I get three figures, and that is all I want. That is one-tenth of 1 per cent, and that is as near as I want to go.

Mr. LANNING. You mean that you get two decimals?

Mr. LEWIS. You can point it off afterwards; you always carry the problem sufficiently in your mind to mark it off.

The CHAIRMAN. That is based on the Arabic system of notation?

Mr. LEWIS. Yes; but it could be based on any system.

Mr. LANNING. Three figures are all you want in any case?

Mr. LEWIS. Yes, sir.

Mr. LANNING. Divide 650 by 28.

Mr. LEWIS. That is 23.3.

Mr. LANNING. You have three figures, but only one decimal?

Mr. LEWIS. Three figures are within one-tenth of 1 per cent. That is close enough. The original data are probably very much more off.

Mr. BROWN. That is in heavy work?

Mr. LEWIS. Yes, sir.

Mr. LANNING. How long has this sliding rule been in use?

Mr. LEWIS. It is as old as I am or older; I do not know, but I should say it has come into general use within the last ten years. It occurs to me that we have the decimal system in our currency, and yet bankers and brokers never hesitate to depart from it and indicate their quotations in halves, quarters, eighths, and sixteenths, using the binary divisions. They return to them right away, because they are the natural subdivisions.

The CHAIRMAN. Quoting from a statement by Benjamin Apthorp Gould, dated February 18, 1888, he says:

In the year 1850 was published a remarkable and useful book by Mr. John H. Alexander, of Baltimore, entitled "A Universal Dictionary of Weights and Measures," and giving the values of standard weights and measures reduced to those of the United States. It contains 5,227 weights and measures, with their equivalents. Leaving aside all which are professedly distinct units, I had the curiosity to count the number of different kinds of pounds, feet, inches, pints, etc. Taking, for example, the various sorts of inches, and using not only the English word "inch," but the corresponding words in other languages, pouce, Zoll, etc., I found 60. For foot, Fuss, pied, etc., there 135. There are 53 different distances called miles, and 29 sorts of pints, while for pound, Pfund, livre, etc., there are no less than 235.

You said that you did not know what a quart was?

Mr. LEWIS. Yes, sir.

The CHAIRMAN. And our friend who has just spoken said he does not know what a perch is. Is there not some confusion growing out of that condition of things?

Mr. LEWIS. Yes, sir; and it is very much to be regretted. I hope something will be done to remedy it.

Mr. HEDGE. What practical embarrassments and cost would come to you in your business, supposing the metric system should be adopted to-morrow and be enforced? I understood you to say that it would be hurtful in some way?

Mr. LEWIS. I do not think that question was put to me, but if we had to build our machinery on metrical measurements and were required to use new taps, jigs, and gauges and everything corresponding, it would practically do away with a very large amount of our invested capital, which would become obsolute, but if we were allowed to build the machines the same as heretofore, and simply call their dimensions by different names, it would be very little inconvenience.

Mr. HEDGE. That suggests another question: Could you not use the new names and apply them to your old machinery?

Mr. LEWIS. We could rename the sizes approximately, not exactly; to give the size it would run out a long decimal with plus at the end.

Mr. HEDGE. Suppose I should ask you to build a machine such as you are building every day, but I should make my specifications under the metric system, you would have no difficulty in building that machine with your present machinery?

Mr. LEWIS. Yes, sir.

Mr. HEDGE. What would be the difficulty?

The CHAIRMAN. With the same machine?

Mr. LEWIS. It would not be the same machine if we had to follow his specifications exactly.

Mr. HEDGE. I want a machine built, which to the chairman would be the same as the machine you built yesterday, but I would make the specifications under the metric system. If you followed out the specifications exactly as I asked, what would be the embarrassment and expense?

Mr. LEWIS. The embarrassment would be that none of our standard gauges would answer for the purpose.

The CHAIRMAN. Supposing that you built that same machine that he has required you to build under the metric system in English measurements, would you not suffer the same inconvenience?

Mr. LEWIS. Yes, sir; because you would add a little here and take off a little there in the sizes—very little differences of no consequence in the final result, but of great importance affecting the cost of construction.

The CHAIRMAN. Supposing he expressed the same measurements that you have and have employed in the manufacture of a machine in metric terms, does that cause you any great inconvenience?

Mr. LEWIS. That would not cause us any inconvenience; it would cause him a great deal of inconvenience to express it.

Mr. HEDGE. What I have never been able to understand is that a great many practical manufacturers have said that it is going to be an expensive thing, and I can not understand why you can not

translate if I give you the specifications, in case I wanted a locomotive, if I were to make my specifications under the metric system, I can not see why you builders could not translate them into any language you choose and make them intelligent?

Mr. LEWIS. Because inches and meters are not commensurate.

The CHAIRMAN. What you mean is this, that if he is going to make new specifications, using metric terms to express them, if they do not agree with the measurements that you already employ, he is going to provide for an entirely new machine and it is going to cause you inconvenience, but if he expresses the measurements you employ in constructing your machine in metric terms, that does not cost you any money or cause you any considerable inconvenience?

Mr. LEWIS. No, sir; but the trouble is that incommensurate terms can not be accurately translated.

Mr. HEDGE. Can not an expert go down to the Pennsylvania depot and pick out a locomotive there and describe that locomotive in metric terms?

Mr. LEWIS. Yes; if he takes the trouble. It depends a great deal upon the degree of accuracy required.

Mr. BROWN. It would take an expert to do that?

Mr. LEWIS. Yes, sir.

Mr. LANNING. Suppose the engineer goes to the locomotive and measures its various parts, it having been made according to our common measurements and he wants to express those measurements in the metric system, has he got to use vulgar fractions? Suppose, for example, he finds a piston rod which is 36 inches long and he wanted to express that in the metric system, has he not got to say that it is a certain number of millimeters and a vulgar fraction besides?

Mr. LEWIS. I do not think he would ever find a fraction to express it. The case is very much like the diameter and circumference of a circle, which is a well known but inexpressible relation either in decimal or vulgar fractions.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., Thursday, March 17, 1904.

The committee met at 10.40 o'clock a. m., Hon. James H. Southard in the chair.

STATEMENT OF MR. WALTER M. MACFARLAND, OF PITTSBURG, PA., ACTING VICE-PRESIDENT OF THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

Mr. MACFARLAND. Mr. Chairman and gentlemen, I had the pleasure of appearing before the committee two years ago, when I was examined at considerable length, and as the former hearings will be available as well as what is said now, I will not attempt to go over the same ground I did before, except as you may bring it out in your questions.

I want to say that I appear as opposed, on behalf of the company which I represent, the Westinghouse Electric and Manufacturing Company, to the compulsory adoption of the metric system. I

understand from what Mr. Southard has explained to me personally, as well as from what occurred at the former meeting, that the bill as it stands does not directly compel any manufacturer to use the metric system unless he wants to, but in my previous testimony I endeavored to point out to the committee that, as the bill was drawn, it would have the effect of making it compulsory, from the fact that the Government is required to use the metric weights and measures in all its transactions. The Government business has such extensive ramifications that my feeling, and that of a great many other manufacturers with whom I have talked about it, is that the demands of the Government on the people who supply the raw materials, if they have to furnish them to the metric sizes, will cause them to insist on supplying metric sizes to general customers, so that it will eventually bring about the adoption of the metric system.

Naturally you will want to know why we are opposed to the metric system. A great deal is said, and you have heard from the advocates of the metric system who have appeared before you a great deal about the facility in calculation and about the beautiful relations of different units, particularly of the relation of the unit of capacity to the unit of length, and of the unit of weight to the unit of capacity and of length. Those statements as to these beautiful relations are quite correct, but they do not have any practical bearing on general manufacturing for this reason: This relation between the unit of weight and the unit of length and the unit of capacity is for distilled water, and of course, as you all know, distilled water is something that in general manufacturing we have absolutely nothing to do with and, except for people dealing with hydraulics, manufacturers have relatively little to do with water at all.

Our business deals with metals of various specific gravities, so that when you come to make your calculation it is practically the same thing, whatever the system of weights and measures; that is, when you come to get a weight from the linear dimensions you have the product of three dimensions decimally together, and that is to be multiplied by the weight of the unit in the English system or by the specific gravity in the metric system. So the amount of work is just the same, and one is as convenient as the other. It will happen occasionally that one will be a little easier than the other.

In other words, after thinking the matter over very carefully (and I may say, as far as I am personally concerned, having approached the subject originally with an inclination for the metric system), and after repeated conferences with progressive engineers and manufacturers, I can not see where, for our business, there would be any advantage whatever in the adoption of the metric system.

In that connection I would like to say a word. When I was here two years ago I was unfortunately compelled to leave the room very shortly after my own hearing, and I did not know what some of those who came after me had said until I saw it in print. One very distinguished gentleman said that he was very greatly surprised to hear me, the representative of an electric company, opposing the adoption of the metric system, because electrical engineering was founded on the metric system, and the metric system was used in all our calculations.

Now, as a matter of fact, that is almost entirely erroneous—I will not say entirely erroneous, but nearly so. The theoretical units at the basis of the electrical system are defined in the metric system, but the

practical units are defined in such terms that of the three chief ones two can be defined just as well in English measure, and the third depends on a natural constant which is independent of any system. I have here a well-known electrical pocketbook—Foster's electrical pocketbook—and in this he gives, under the head of "Electrical engineering units," what he calls "International electrical units," which were adopted at the International Congress of Electricians held at Chicago in August of 1893. He goes on to define the unit of resistance, the ohm, as follows:

The international ohm, which is based upon the ohm equal to 10^9 units of resistance of the C. G. S. system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at a temperature of melting ice, 14.4521 grams in mass, of a constant cross sectional area, and of the length 106.3 centimeters.

Now, you can see that could be just as well defined in English measures. In the same way he gives the definition of the ampere:

The international ampere, which is one-tenth of the unit of current of the C. G. S. system, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the accompanying specification, deposits silver at the rate of 0.001118 gram per second.

That can be defined just as well in English measure. And then the unit of electromotor force, or the volt, is defined as a certain proportion ($\frac{1}{1434}$) of the electromotive force of a Clark cell. That, you will see, is independent of any system of measurement. So much for the units.

Now, as a matter of fact, I took great pains before I came down here two years ago to consult with our engineers, and I consulted them again before coming here this time, and they told me that they do not use the metric system in their calculations at all. All their data and all the records are in English measure, so that the scheme of changing over to the metric system would involve absolutely recasting all these things into the metric system, which would represent a great deal of trouble and considerable loss and expense.

It has perhaps been pointed out here by some of the previous witnesses, as I know one of them inquired about it, that we have to-day men connected with our company who have been brought up, so to speak, in the metric system, and then came to work in the English measures, afterwards going back to our French factory; yet notwithstanding their early training these men have found it, on account of the possession of the data in English measure, more convenient to make their calculations and to work in the English system. I have emphasized these things to show why the reasons ordinarily assigned as arguments in favor of the greater convenience of the metric system do not apply in manufacturing, so that we do not see any advantage to us on that score. On the contrary, to make the change would involve us in a great deal of expense and inconvenience, and there undoubtedly would be a tremendous amount of annoyance in the transition period. We believe there would also be a great many errors, as there always will be errors in a transition period.

When I was here before I stated that I had asked our people, including the superintendent of the works, who is familiar with the mechanical details, as to what it would cost us to make the necessary changes in jigs, dies, templets, patterns, and things of that sort, as

well as changes that would have to be made in the machinery. One estimate was $300,000 and another estimate $500,000. Our drawings would also have to be changed, but there are many that are old, and others of special machines, which we probably would not change. However, taking the live drawings, where the changes would have to be made, and we estimate that it would cost us a quarter of a million dollars to change them.

The CHAIRMAN. You estimate that you would have to change all your drawings?

Mr. MACFARLAND. We assume, from our knowledge of the business, that we would have to make the change to the extent mentioned above. Now, I do not want you to understand that we would have to throw away all of our tools. As Professor Sweet will tell you, there are some tools, like planers, shapers, and slotters, where there is no question about measurements to come in, and you could do work with them on any scale, but some others would require changes in parts. These changes are not so much in the main tools themselves as in the auxiliary equipment, and I ought to say that while calling it auxiliary, it is nevertheless most important. Indeed, these special tools and fixtures are really what have gone to make the essentially American system of manufacturing—that is, of manufacturing standard sizes and of sticking to them, instead of building to order and making any size that is wanted. I was asked when I was here two years ago if we did not build machines as they were ordered. I said that that was relatively rare, and that we discouraged that practice to the greatest possible extent. We prepare a set of designs, and we experiment and develop them until they are as perfect as we can make them, and then we continue to manufacture those standard sizes right along.

The CHAIRMAN. Would it be necessary to change any templet, jig, or die, or anything else, in the making of that machine, so long as you continued to manufacture the same machine?

Mr. MACFARLAND. No, sir; as long as we make that same machine, of course we do not need to change anything. But the reason for making these changes in drawings and everything else is this: If we are going to adopt the metric system, we will have to manufacture in the metric system just as we at present manufacture in the English system, to the exact divisions of the scale. This is a point that I tried to make clear when I was here two years ago, but I seemed unable to impress its importance on the committee.

I believe it is not because you are not intelligent men; that goes without saying, but because most of you gentlemen are lawyers, not engineers or mechanics, and your training has not been along the line to make you appreciate a point like that. It seems a trifling point to you, and one as to which Mr. Southard said a short time ago, very pleasantly, to be sure, in conversation with me, "There is no point to it."

Now, I have here a scale with two divisions, one marked inches, and the other marked millimeters. These dimensions are enlarged to four times the actual size, so that the millimeters and small divisions of an inch could be compared, and so that you could see that the divisions of the scales hardly match in a single case. One of the most familiar dimensions is the inch, which is between 25 and 26 millimeters, or, to be exact, 25.4 millimeters. Now, it is a fact that in efficient manu-

facturing—and Professor Sweet and Professor Kent will bear me out later—you must work to the exact sizes.

At the hearing before the committee two years ago the gentleman who represented the General Electric Company, Prof. Elihu Thompson, favored the change to the metric system, and he quoted a number of the engineers of that company as favoring the change; but everyone of them, as will be found from an examination of the printed testimony, took exactly the same view as I did—that you would have to change the dies, the templets, and jigs, and they agreed that it would cause a great deal of annoyance, trouble, and expense, but they seemed to think the change was worth the trouble.

The CHAIRMAN. But you all agree that as long as you manufacture the same machine you would not have to change the tools.

Mr. MACFARLAND. Not so long as you manufacture the same machine.

The CHAIRMAN. And you would not have to change your plans.

Mr. MACFARLAND. Then you would never adopt the metric system. But the point is that the tools wear out; your jigs and dies and templets wear out. For instance, our dies that stamp out the sheet steel punchings for the cores of armatures only last for a short time, and we have to make a great many dies for the numerous machines from one design.

The CHAIRMAN. In reproducing that machine you would reproduce the same tools.

Mr. MACFARLAND. You would have to make them to the same size. For instance, if you attempt to do some work to one system and some to the other all through the shop, you would have some things built in English measure and some in metric measure, and you would have the most interminable confusion; and that would cause a serious loss. If the metric system ever comes in such shape that it will have to be adopted, people will certainly go to work and adopt it as promptly as possible.

The CHAIRMAN. Is it not true that there is not a standard manufacturing company anywhere in the country where they do not manufacture in metric sizes if you want them?

Mr. MACFARLAND. I do not think there is any place where——

The CHAIRMAN. Is it not true that there is hardly a manufacturing institution in the country in which manufacturing is not done in metric measurements if it is desired?

Mr. MACFARLAND. Yes; that is true.

The CHAIRMAN. Well——

Mr. MACFARLAND. But as I said in my first answer, judging from the experience of my company, we have little or no demand for work to metric dimensions, the fact of the business being that the countries of any importance as possible purchasers which use the metric system are very largely high protectionist countries (such as France, Germany, and Italy), and it is absolutely impossible to manufacture things here and sell them there. This, of course, brings up the question of the export trade.

Now, as far as the export trade is concerned, there may be some concerns to whom it is an important thing. If it is, their interest would lead them to adopt for export to metric countries the metric system for manufacturing without any governmental compulsion. It is the usual case of demand and supply. If a firm has a demand

for a certain class of product it will arrange its manufacturing establishment to fill that demand as cheaply as possible. If the demand is from metric countries, of course the shop will manufacture in metric sizes; but where from 95 to 99 per cent of one's demand is in English measures, it is a curious thing to expect that one should shift over to the metric measure for that 1 per cent of his business.

I would like to say a word more, and I will take just a moment to present these additional points, and if you see fit you can put them in, and if you do not, you need not.

The CHAIRMAN. We will put them in if you desire it.

Mr. MACFARLAND. The point that struck me very forcibly in going over the hearings of two years ago is that the people who come here to advocate the adoption of the metric system are very largely people who personally will not be affected by it. You might say they are philanthropists; they are liberal-minded people who want to see their fellow-men get the benefit of this change. We, who oppose it, do so because it is going to cost us a lot of money and a great deal of trouble and inconvenience without any corresponding benefit.

I happened to read not long since a very interesting book by a gentleman who appeared here two years ago shortly after I did and who criticised my testimony, intimating that I did not know my own business, and that he knew more about it than I did, although he probably had never had anything to do with manufacturing. In that book is a statement of how he felt toward a change in a matter where he is an expert, and inasmuch as his attitude in that case is just the same as my own attitude with respect to this matter of the metric system, and expresses this attitude very clearly and forcibly, I would like to read you what he says. It is short, and I think will be interesting to go into the record. This is an extract from "The reminiscences of an astronomer," by Prof. Simon Newcomb. He says (and I quote from pp. 227 and 228):

One proceeding of the conference illustrates a general characteristic of reformers. Almost without debate, certainly without adequate consideration, the conference adopted a recommendation that astronomers and navigators should change their system of reckoning time. Both these classes have, from time immemorial, begun the day at noon, because this system was most natural and convenient, when the question was not that of a measure of time for daily life, but simply to indicate with mathematical precision the moment of an event. Navigators had begun the day at noon, because the observations of the sun, on which the latitude of a ship depends, are necessarily made at noon, and the run of the ship is worked up immediately afterwards. The proposed change would have produced unending confusion in astronomical nomenclature, owing to the difficulty of knowing in all cases which system of time was used in any given treatise or record of observations. I therefore felt compelled, in the general interest of science and public convenience, to oppose the project with all my power, suggesting that, if the new system must be put into operation, we should wait until the beginning of a new century.

"I hope you will succeed in having its adoption postponed until 1900," wrote Airy to me, "and when 1900 comes, I hope you will further succeed in having it again postponed until the year 2000."

The German official astronomers, and, indeed, most of the official ones everywhere, opposed the change, but the efforts on the other side were vigorously continued. The British Admiralty was strongly urged to introduce the change into the Nautical Almanac, and the question of doing this was warmly discussed in various scientific journals.

One result of this movement was that, in 1886, Rear-Admiral George H. Belknap, Superintendent of the Naval Observatory, and myself were directed to report on the question. I drew up a very elaborate report, discussing the subject especially in its relations to navigation, pointing out in the strongest

terms I could the danger of placing in the hands of navigators an almanac in which the numbers were given in a form so differnt from that to which they were accustomed. If they chanced to forget the change the results of their computations might be out to any extent, to the great danger and confusion of their reckoning, while not a solitary advantage would be gained by it.

There is some reason to suppose that this document found its way to the British Admiralty, but I never heard a word further on the subject except that it ceased to be discussed in London. A few years later some unavailing efforts were made to revive the discussion, but the twentieth century is started without this confusing change being introduced into the astronomical ephemerides and nautical almanacs of the world, and navigators are still at liberty to practice the system they find most convenient.

I was talking over this proposed adoption of the metric system with a friend, and he made a suggestion to me this way. We were discussing the point I made two years ago, that an engineer, or any man who is using any system of weights and measures, as time goes on acquires a large number of constants and valuable data, which he has at his fingers' ends and can call up instantly; for instance, the tensile strength of various metals, the amount of coal that is burned on a square foot of grate surface with various degrees of draft, and hundreds of others.

Professor Kent here could give you a string of those figures a mile long. Now, in the change of the system of weights and measures, these data drop out at first, and the new measures mean absolutely nothing. I venture to say that there is not a man in this room who could tell me its temperature on the centigrade scale. It certainly means absolutely nothing to me until I translate it into Fahrenheit temperature, and then it conveys a real meaning. Suppose it has taken a man ten years or more to get all these data so that he can use them with facility, so that he has them at immediate command without using reference books. It would take him almost as long to get a realizing sense of those quantities in the new measures. In other words, a trained and experienced man, when he has shifted over to the new system of weights and measures, is almost on the same footing as the boy just out of college in these things. The rapid use that he could make of these data has gone from him.

My friend said that perhaps I could make the committee realize the force of this point in this way:

The French language is a beautiful one. Many people think it is a more logical language than the English. Probably it is, in some ways, just as they claim that the metric system is more logical than the English system. It is noted for its clearness, and people generally are agreed that scientific works written in French are probably clearer and easier to understand than in almost any other language. Now, since the French language is so good, why not adopt it and make the French language the one to be used in our country, instead of English, and require that, after two years, the use of the French language should be compulsory, and that every speech made in Congress should be in French?

He said, "Don't you see the point? By the time a man is 40 years of age he has mastered his mother tongue, and he can choose instantly the exact shade of meaning that he wants; and men of the culture and mental strength of members of Congress could get a pretty thorough acquaintance with French in two years, but they would not in twenty years get this mastery of these delicate shades of meaning which they have in English." That is just the point about losing the benefit of data that you have acquired in the English system when you change to the metric system.

Mr. CANDLER. Do you know any practical benefit to be derived from this to the business interests and men of the country, from this change to the metric system?

Mr. MACFARLAND. I do not.

Mr. DRESSER. A uniform standard of weights and measures the world over would be a benefit to the world?

Mr. MACFARLAND. Yes, sir; if it were practicable to secure it at a reasonable cost.

STATEMENT OF PROFESSOR SWEET.

Mr. SWEET. I am very glad Mr. Macfarland has taken up so much of the time, because he has done so much better than I could in the same time.

In appearing before your committee I represent the Engine Builders' Association of the United States, and in their behalf wish to enter a plea for an adverse report on the metric bill.

We base our right to appeal on the ground that it is not only greatly against our interests, but because we believe it to be an unwise thing for the Government to inaugurate.

The advocates of the measure must think that if the law is enacted and the Government authorities carry out the law, as they are bound to do, eventually the system will be forced upon the people in general, for no one would advocate having the Government work for all time made to metric measures while everything else was to go on the English measure; and hence, if the change is inaugurated, it must be with a view of its ultimate universal use. But universal use is impossible. Our land measures, our railroads, and our buildings must always be in feet and inches, not because it is impossible to build buildings by the metric system, but the builders simply will not, for the tools are entirely unsuited to the building trades.

Hence, if this bill is passed, whether only used by the Government or extended to machinery, to commercial transactions, and to the farm produce, there will be for all time two systems of linear measure, and two that are incommensurate and only comparable by endless figures.

It is the belief of the people I represent that the actual advantages of the metric system over the English are greatly overestimated, and further that in many respects it is not as good; and still further that the number of people to whom the advantages will accrue is only thousands at most, and that those to whom the disadvantages will come are millions. The advantage will come to those who have foreign trade, who plan and figure, and the disadvantages to about everyone who makes anything, the ones that only trade locally, and farmers. The reason the metric measure to make things is not as good as our own is because no one has or ever can make a metric rule comparable to our two-foot rule or carpenter's square in convenience.

The decimal division is not so convenient as the natural one. Our foreign trade is largely in grain, cotton, and machinery. It is claimed, and no doubt believed by some, that our trade in machinery would be extended if built by metric measures. This need not be referred to opinion, but left to facts. In our association everyone has been doing a foreign trade, and many of them to a considerable extent in metric-

using countries. Not one ever had an inquiry as to whether they would furnish an engine made to the metric measure. We have enterprising firms in both the engine and the machine-tool trades. If there had been or is any demand for machinery made to the metric measure is it conceivable that the most enterprising of our builders would not have fitted up secretly and built such machinery and rushed it in ahead of their competitors? Such a demand does not exist, or if it does, the excessive cost has prevented our enterprising manufacturers from meeting it, and if that is the reason it simply proves that the game is not worth the candle; and if not for any one firm, how can all firms get their money back out of foreign trade?

As to the advantages in the grain trade. Assume the farmers were to use the metric system of weights and measures, and sell to the dealer so many kilos of wheat. The dealer adds together all his purchases and sends them to the exporter. The exporter adds his purchases together and determines he has bought so many kilos, and so ships and bills so many, say ten thousand metric tons, to France. Now, what happens; does he get pay for ten thousand metric tons? Not at all; the grain is weighed and he gets paid for what he delivers. If it overruns, as it may by dampness, or shrinks, as is likely by carelessness or theft or leakage in any way, there is exactly the same figuring to do to fix the amount as there would be if the grain came to the exporter in pounds or bushels and the exporter turned to his table of equivalents, finding that his 21,000 pounds was the equivalent of 10,000 kilos, and billed his shipment by that.

Now, what has been saved in the export trade in grain by the complete adoption of the metric system? One man's time, while he consults a table for every transaction after it reaches the shipping port. And what has this cost the eight or ten million farmers? The cost of their weighing and measuring implements, or, say, $5 each, making forty or fifty million dollars in all. In the cotton trade it would be nothing gained, for the bales have no standard weight. There are likely other things where the proportionate gain would be greater, but these are the three great items, and of all it would seem that if there was any gain in anything we export it would be machinery. That there is gain in general in figuring by the decimal system no one will question, but it is not all gain in mechanics, as it takes so many more figures where the millimeter is the unit rather than the inch, because of the smaller size; and, too, the decimal system admits of no short cuts, as is common in the use of vulgar fractions.

Of the things we have to do, as frequent as anything is the squaring of numbers and determining the area of circles.

For the area of circles say the equivalent of 7 inches, or the even 175 mm., it takes the multiplying of 49 by 3.1416 in the case of 7 inches, and in the other of multiplying 175 by 175, which is 30625, and then this number has to be multiplied by 3.1416. This example is so in favor of the English system as to be past comparison. Again, we may wish to multiply $6\frac{3}{4}$ by $6\frac{3}{4}$, or $7\frac{1}{8}$ by $7\frac{1}{8}$, or $4\frac{1}{2}$ by $4\frac{1}{2}$, all of which would seem to require quite a number of figures, while anyone who is at all good at mental arithmetic can learn to do it in ten minutes, and do the example before the decimal man can get out his pencil and paper.

The CHAIRMAN. Suppose you wanted to square $4\frac{19}{32}$.

Mr. SWEET. That takes more. I can not do that in my head.

The CHAIRMAN. We are perfectly familiar with the decimal equivalents for those things, when they are multiplied together.

Mr. SWEET. Then you can do it the other way, but you must get out your pencil and paper.

The CHAIRMAN. And there is no question but what either system lends itself to what you would call binomial subdivision, almost equally.

Mr. SWEET. I do not wish to hold up the vulgar fraction system as better than the decimal, but maintain that it is in many cases the better of the two, and subdividing by two is the natural thing to do; our system was built up on that, and our system of weights and measures, for people who make things of any magnitude and for the common people, is the better of the two.

From these facts I am satisfied that the value of a system of weights and measures for our country to be uniform with those of other countries is vastly overestimated. Of machinery, which it would seem is the thing of the most importance, bolts and nuts come first. In this the Whitworth (which nearly corresponds with our own) pitch of threads is used more universally than any other. Other countries use others, but no two alike. The next comes gas and water pipe. There are a million screwed joints of gas fittings now in use in this country, Canada, and Mexico, to every one where our own and those of other countries have to come together. The man who would propose to change our system of bolts and pipe threads would be a fit subject for an idiot asylum.

Those who advocate universal adoption of the metric system refer to the number of other countries which have adopted it. To this should be given not the weight of numbers of countries, but of the amount of weighing and measuring that is done in those countries by the metric system and the amount done in the English system. Take Mexico, Belgium, and Sweden; these countries I happen to know something about. The bulk of the machine work in Mexico is done by the railroads and by the English measure; in the local markets trading is done by the old Spanish measure; the land surveys and the mining work are by the metric, and nine-tenths of the houses are of mud brick built by guess.

I found them using the old Spanish system. You go around in the central market of the city, where the old people sit on the ground and sell all those things that you would not want to eat, but which they seem to eat down there, and they use these little old scales, you know. Those are the common people, and they understand what they are about, and there are a good many common people in proportion to the educated.

Now, you see hundreds of thousands of those mud-brick houses down there, and do you suppose that they had any metric measure about it? I do not.

The CHAIRMAN. I do not think they had any.

Mr. SWEET. No; of course not. I do not believe there is a man who has traveled through the country who would not concede that there is more weighing and measuring done in the cities of Cleveland and Buffalo than in the entire Republic of Mexico. In Belgium or

Sweden you can order machinery, or could six or seven years ago, in either the English or metric system, and get it at the same price, and, what is not generally known, the machinery would be of the highest class.

My many years' experience with the metric system has convinced me that if forced into use in this country it will cater to a false sentiment, and, so far as linear measurements go, lead to endless confusion and be of negative commercial value. Now, it is possible you are not familiar with the metric rule. I have one here. They are not all made that way. Some of them are twice that length, so that you only have five folds [exhibiting folding pocket measure].

The CHAIRMAN. You have said that you are constantly making engines for metric countries.

Mr. SWEET. I say members of our association are making them.

The CHAIRMAN. Your association?

Mr. SWEET. Yes; I speak of that association. We ourselves have made a good many.

The CHAIRMAN. And you never have had any complaint that they are made in our measures?

Mr. SWEET. We never have had any inquiry.

The CHAIRMAN. No inquiry; and yet you think if the Government should adopt the metric weights and measures it would cost you a good deal of trouble?

Mr. SWEET. On the assumption that it was adopted by the country. I started out with that assumption. If the Government did it——

The CHAIRMAN. This is a bill which requires simply the Government offices, or the departments of the general Government, in transactions involving the weights and measures, to use the metric weights and measures. If you can manufacture for metric countries and build machines and sell them there, why could you not manufacture those particular machines for the Government and sell them to the Government, provided the Government needed those machines? You are talking about countries where the metric system is compulsory.

Mr. SWEET. Yes, sir.

Mr. MACFARLAND. May I answer that?

The CHAIRMAN. Certainly.

Mr. MACFARLAND. Professor Sweet, when you furnish engines built on English dimensions to go into metric-using countries, is it with the understanding through your agent that you will always supply the repair parts necessary for those engines?

Mr. SWEET. We have never had any occasion to send one in the metric system—never have been required to.

The CHAIRMAN. That is all I wanted to inquire.

Mr. MACFARLAND. They never wore out?

Mr. SWEET. You mean when we have furnished them in English measure?

Mr. MACFARLAND. Yes; you stand by to furnish necessary repair parts?

Mr. SWEET. Yes, sir.

The CHAIRMAN. Free of charge?

Mr. MACFARLAND. Oh, no.

The CHAIRMAN. You always do that, of course?

Mr. MACFARLAND. It makes all the difference in the world. If we

go into building to the metric dimensions we have to furnish repair parts. It would look as though the people would find no difficulty with those engines built on the English measure, from what Professor Sweet said at first. The reason that they find no difficulty is because they can send back and get the repair parts from him.

The CHAIRMAN. The point I was making is that the repair parts could be secured here as easily as they can be in a foreign country.

Mr. SWEET. Yes, sir; and everything that the Government orders, are they not to order it in the metric weights and measures?

The CHAIRMAN. I beg your pardon.

Mr. SWEET. I say if this bill is passed, when the Government orders a steam engine, is it not to be in the metric measure, according to that law?

The CHAIRMAN. I take it the Government would order an engine without necessarily saying anything about the weights and measures in that particular case.

Mr. SWEET. Is not that your interpretation of the law instead of a Government officer's interpretation of the law?

The CHAIRMAN. Of course the bill is here. I was simply indicating what I thought would be done.

Mr. SWEET. What you think; yes, sir. Well, we have had something to do with Government work—not much, but a little—and it is our conviction that when the Government officers are ordered to do a thing they are pretty likely to stick to it and do it. We know a good deal about inspectors, directly and indirectly, and their orders are to see that the specifications are complied with, and they are not to use their own judgment as to whether such and such a thing is just as good or not, or anything about it. For instance, if there is a shaft ordered so many millimeters, and that is pretty near 3½ inches, the first inspector may accept it and the next man reject it; they say the shaft is ordered so many millimeters, and that they must have.

The CHAIRMAN. In ordering them they would not necessarily specify the size, as I take it, of each particular part?

Mr. SWEET. They come to us frequently and they say "The cylinder must be so big and the stroke must be so long," and so on. Those orders are coming to us constantly from our own engineers, and I do not know why the Government would not do the same thing.

To illustrate the trouble that it is, it has been stated recently that the Russians sent the wrong shot to Vladivostock, and it varied 1 millimeter from being right, and the result was that at Vladivostock for one or two days they did not have any ammunition. If you take an 8-inch shot and a 200-millimeter shot they are so near that no man can tell the difference without putting a pair of calipers on them, but the one, the big one, will not go into the gun, and the little shot will not take the rifling in the other gun.

The CHAIRMAN. If you make standard guns and standard shot, they will fit as well in one system as in the other?

Mr. SWEET. If you do not change; but if you change there is the trouble. If you change to the metric system——

The CHAIRMAN. But the change in the system does not make a change in the size of the shot or the guns.

Mr. SWEET. Yes, sir; but they will not stick to that. There is no naval officer who is going year after year and year after year to make

203.8 guns when they have adopted the metric system. You have a 75-millimeter gun now in the Army. Now, they are going to stick right to that 75-millimeter gun.

The CHAIRMAN. Let me ask you this: Supposing we should change from one system to the other, what would be the necessity of changing the size of the gun?

Mr. SWEET. Simply because you do not want to continue year after year and year after year this long string of decimals at the tail end of your table.

The CHAIRMAN. You have got the tools for manufacturing one size of gun. What is the necessity of changing the size of the gun?

Mr. SWEET. Just as much as there is for changing our system of weights and measures.

The CHAIRMAN. None at all, you would say?

Mr. SWEET. None at all.

The CHAIRMAN. Now, do you believe there is any advantage to be gained by having a universal system of weights and measures, and, if possible, a universal language in weights and measures?

Mr. SWEET. Not enough to pay the cost.

The CHAIRMAN. Do you think there is any advantage to be gained from an educational standpoint in the change from one system to the other?

Mr. SWEET. No, sir.

The CHAIRMAN. That is all.

Mr. SWEET. I would like to have the gentlemen see this rule [indicating folding pocket rule].

The CHAIRMAN. We have had those here frequently.

Mr. SWEET. I simply want you to look at the millimeters. This is a German rule, and has four measures on it. This fine side is the millimeter side. Now, in the French they adopt the millimeter as a unit, because they could not use the centimeter. If they used the centimeter and put the decimal point after the centimeter it would be in the wrong place [indicating on rule]. Now, the Germans use two sides of that rule and the French use two sides of it, but not the same two sides.

STATEMENT OF MR. WILLIAM KENT, DEAN OF L. C. SMITH COLLEGE OF APPLIED SCIENCE, SYRACUSE UNIVERSITY.

Mr. KENT. I do not know, Mr. Chairman and gentlemen, that I have any beneficial interest in the metric system one way or the other, and I do not think that it will affect my pocket whether the metric system is adopted or not.

Mr. MACFARLAND. Before you begin, Professor, you are now professor of mechanical engineering and dean of the School of Applied Science in Syracuse University, New York.

Mr. KENT. I have been there for a little less than a year.

Mr. MACFARLAND. And before you accepted that chair in Syracuse University you were a consulting engineer for a number of years?

Mr. KENT. Yes, sir.

Mr. MACFARLAND. So, Mr. Chairman, you see that Professor Kent is not a theorist, but he is a practical man.

Mr. KENT. I first became acquainted with the metric system nearly forty years ago when I was a student in the central high school at

Philadelphia. It then was being introduced into the schools and a considerable agitation was made about it, so that I became quite familiar with it. In 1875–76, when I was a student of chemistry and engineering in Stevens Institute, I had frequent occasion to use it, and in my work as assistant to the United States board appointed to test iron, steel, etc. (1875–1877), I used it to some extent, both in weighing and measuring. Some of the professors in that institute were strong advocates of the system and I became an advocate of it myself, so much so that I wrote some articles in the American Manufacturer, of Pittsburg, Pa., in 1877–78, when I was editor of that paper, in favor of it.

In 1880 Mr. Wm. Metcalf, who was then president of the Engineers' Society of Western Pennsylvania, asked me to write a paper for the society attacking the metric system. I replied to him that I could not very well do that, as I was on record in favor of the metric system. He said: "All right, write a paper in favor of it, and then we will attack you." I consented and wrote a paper, which is published in the first volume of the proceedings. In preparing that paper I read all the literature I could find on the subject, and in it I gave the arguments on both sides. The result of my investigations while preparing the paper are expressed in its concluding paragraph, which is as follows:

> If my hearers now think that I have only "straddled" this question and not planted myself as firmly as they could wish on one side or the other, I will now define my position. I think that theoretically the metric system is a very good system. Practically, it is practicable in some things, impracticable in others. In regard to Government interference, I hold about the position of Ensign Stebbins on the Maine liquor law; he was in favor of the law, but opposed to its enforcement.

The paper itself will show that my investigations of the metric system led me to realize the fact that the difficulties in introducing it were so great as to overbalance its advantages. The paper, however, was considered by Lieut. F. A. Mahan, U. S. A., who was then a member of the society, to be so antimetric that he wrote a paper in favor of the metric system, apparently as an antidote to my paper. The concluding page of his paper contains the following:

> The schools of science all through the land are teaching the metric system, many of them having adopted it exclusively. The graduates of these schools will be the directors of the future, and they, knowing its advantages, will bring it to the front. Engineers will demand it, and manufacturers must yield to it or be left behind in the race. Those who have used the system enough to understand it thoroughly, who have a knowledge of it gained from everyday use, and who have seen its convenience in every direction, are in its favor. The opposition is mainly made up of those who, in the words of a prominent member of our society, "don't know and don't want to know anything about it."

In the twenty-four years that have elapsed since Lieutenant Mahan's paper was published, his prediction of the adoption of the metric system by engineers has not yet come true. The graduates of the schools are the directors of the present, and they have not brought the metric system to the front; engineers do not demand it; manufacturers have not yielded to it, and they have not been left behind in the race. On the contrary, since the paper was written the manufacturers of the United States have advanced this country to the position of the first manufacturing country of the world.

Let us turn from what Lieutenant Mahan, now Major Mahan, said

in 1880 to what he said the latter part of last year. The American Machinist of January 14, 1904, reporting Major Mahan's discussion of the metric system at a meeting of the Société des Ingénieurs de France, says:

> In 1876, Major Mahan came to France, where he spent three months in studying the interior waterways. His studies gave him a great deal of experience with the metric system, the value and convenience of which he soon realized. Since then he had employed it a great deal, and above all when he had difficult computations to make. Often he had converted his American data into metric terms; made his computations, and reconverted the results. By this means he had often realized an economy in time of 50 per cent.
>
> But, on the other hand, the mind had an inertia that it was difficult to overcome. Although he was a great partisan of the metric system, and had employed it largely for thirty years, he always experienced great difficulty in thinking in that system. When stresses of so many kilograms per square centimeter were mentioned, no idea was conveyed to his mind, and he found it necessary to convert them into pounds per square inch. It was very difficult for Americans who had the habit of the latter form of expression, and who heard no other about them, to at once understand what was meant by measures expressed in kilograms and centimeters. This form of expression frightened the American people a little, because they did not understand it, and it was difficult to make them appreciate the great advantage of the metric system over the one actually in use.

Thus we find that Major Mahan himself, after thirty years' experience of the system, and a public advocate of it twenty-four years ago, to-day finds it difficult to think in the metric system. How, then, can we expect the American people, who have not had the same advantages Major Mahan had, to think in that system?

Since the preparation of my paper in 1880 I have read nearly everything that has appeared in the engineering periodicals concerning the metric system. I have had frequent occasion to use it. When I was general manager of the Springer Torsion Balance Company in 1886, I designed the first scale that was ever engraved on celluloid (it was a combined English and metric scale), and I did a good deal of work in advancing the use of the metric system in the druggist trade, but the results of my observation and study for twenty-four years has only confirmed me in the opinion that I have expressed in the paper in 1880 that the difficulty of introducing the metric system into America is so vast as to make it an impossible task. I said in that paper:

> Yes; first establish an international money system, successfully accomplish the reform in the spelling of the English language, teach all the nations of the earth to speak one universal language, or do any other desirable but Herculean labor which finds its chief hindrance in the habits, traditions, and prejudices of millions of the human race, and you may be prepared to undertake such a revolution as would be the substitution of the meter for the 2-foot rule.

The difficulties which then, in 1880, hampered the introduction of the metric system have since that date increased many fold. The mechanical engineers and manufacturers who have appeared before this committee have explained the impossibility of wiping out the English system in our machine shops, and other men have argued other phases of the subject.

I wish to touch only one phase, which has probably not been considered to any great extent by the men who have hitherto appeared before the committee. I refer to the inconceivable magnitude of the task of wiping out or translating into metric measures the English literature based on the English inch and foot, and the enormous

number of records in manufacturing establishments based on the English measurements. I read in the American Machinist, January 28, 1904:

The vaults of the Bucyrus Company contain about 20,000 tracings, made through a period of perhaps twenty years. Of the full-sized sheets perhaps 1,500 are liable to be used on new work, while at least 8,000 of the small sizes are still alive. It is evidently impossible to consider any system which does not provide for using these old drawings.

When it is considered that every one of these 20,000 drawings has numerous dimensions on it, every one of them in the English system, an idea may be formed of the task of translating these drawings that are still alive into the metric system.

In the same issue of the American Machinist there is a copy of a single shop order which was made on tracing cloth by the Bucyrus Company, specifying the different things that go into the manufacture of one elevator dredge. There are listed 73 different kinds of articles, and every one of these articles is specified by its dimensions in the English system. For instance, the first item is a gear with 70 teeth, 2½-inch pitch, 7-inch face, 7-inch bore. Every machinist in America knows exactly what is meant by these items and forms a mental picture of the size and shape of the gear. Translate these dimensions into the metric system and how many mechanics could form a mental conception of the gear until after they had translated the metric measures into English?

In 1895 I published a Mechanical Engineers' Pocketbook, of which more than 30,000 copies have been sold. The collection of the material for this pocketbook took more or less of my time for twenty years, and the making of the book not less than three years' full time. The things compiled in it involve reference to engineering works, papers, and periodicals, some of them dating back at least sixty years. There are 1,100 pages in the book and each page has about 900 words. The number of figures and formulæ in the book which are based on the English inch run into more thousands than I would care to figure. The task of getting such a book free from errors is a tremendous one. Over a thousand typographical and other errors have been reported in the last eight years.

Mr. John C. Trautwine, jr., told me some twenty years after his father's Civil Engineers' Pocketbook was first published that he was only then beginning to feel that his book was reasonably free from errors. If my book were translated into the metric system, it would be at least ten years before all the errors in the translation would be rectified. I doubt if the translation could be made without at least five years' hard labor of an expert mathematician.

Last year the American Society of Mechanical Engineers appointed a bipartisan committee to report on the metric system. Mr. James Christie and Fred J. Miller were appointed to report the arguments in favor of the metric system and Mr. George M. Bond and myself were appointed to report the arguments against it. You will find our complete report in the transactions of the society, volume 24, beginning on page 630. In this report both sides of the question were represented, I think, in a more complete manner than they were ever before.

I would ask the committee's attention especially to Appendix IX, page 691, entitled "The Metric System: A Big Job for a Literary Engineer." I quote as follows from that letter:

> The big job, however, would be to produce the literature of the transition period. It would include, in the tables of beams, for instance, all the existing standard sizes, in even inches of depth, with their corresponding metric equivalents to the nearest tenth of a millimeter, together with the dimensions, both English and French, of length, breadth of flange, and thickness of web, the weight per yard and per meter in pounds and kilograms, and the coefficients for computing strength in both systems. Besides this, there would have to be new tables of the new sizes, 20 to 600 millimeters in metric measures, and their English equivalents.

The CHAIRMAN. But so far as beams are concerned, I may say that the inexactness of their sizes would make it not difficult to find exact sizes or nearly sufficient exact sizes.

Mr. KENT. There is practically no inexactness of the sizes. They are all standardized now, and calipered to the one-hundredth of an inch, or to the two-hundredth of an inch, possibly. They would not allow as much as one one-hundredth of an inch, I believe.

The CHAIRMAN. I have been told that in the manufacture of beams there would be no trouble in obtaining exact sizes.

Mr. KENT. I think in small beams, in 3 and 4 inch beams, one one-hundredth of an inch to two one-hundredths of an inch would cause a rejection, if it was that much thinner in the web. We would have a 3-inch beam and a 75-millimeter beam. The difference between them is considerable, and probably they would not use a 75-millimeter beam, but an 80-millimeter beam. There would be two sets of sizes, English and metric, and there would have to be two sets of measurements for each size.

I would like to explain this further to you. Every machine shop in the land has a twist drill which will drill an inch hole, and when an inch hole is called for to be drilled in a plate, the tool that drills it has a shank, and the drill press in which you hold the drill has a socket made to fit the shank of the drill—a tapered socket.

Now, if the metric system is adopted to any extent in our shops, a man will be called on to drill holes both 25 millimeters and $25\frac{4}{10}$ millimeters, or 1 inch, in diameter, and he has to have drills that will drill both sizes of hole. He has a shank made to fit the British system, and a British socket in his drill press. He can buy a metric drill, perhaps, with a British shank and a metric drill, but after a while the metric system gets adopted a little further, and then he will put in a drill press with a socket for taking metric sizes only, and he will still get orders to drill inch holes and also orders to drill 25-millimeter holes.

The CHAIRMAN. Suppose he puts in a press with the same kind of socket that he had before; then he will not have but one socket.

Mr. KENT. He will have a metric socket in one press and a British socket in the other.

The CHAIRMAN. Suppose he does not put in a metric socket.

Mr. KENT. Then he will have only a British socket, and in order to drill a 25-millimeter hole he will need to have a metric drill with a British shank; that is, a drill which is part metric and part British. Then if he gets a new drill press after the metric system has been partly introduced and it has a metric socket, then in order to utilize both the old and the new drill presses for boring any standard size of hole, either British or metric, he will have British drills with

metric shanks, metric drills with British shanks, and metric drills with metric shanks, or three different drills besides the original British drill with a British shank. Thus, every machine shop will be compelled to have four different kinds of drills to do the drilling of what is practically a 1-inch hole.

The CHAIRMAN. Is it not true, Professor, that you are trying to multiply these difficulties just about as much as you can?

Mr. KENT. Absolutely not, sir. On the contrary, the argument against the metric system is so overwhelming that it is only a question of selecting out those points that have not been presented to the committee before. I could spend a year furnishing literature on that subject. To continue my quotation from the paper I have referred to:

During the transition period the mechanical articles in the Encyclopedia Britannica, and all other cyclopedias and other works of general reference, would have to be printed in the transition language, otherwise they would not be readable to the people of the period. When the reform (?) was at last accomplished they would have to be reprinted again, making them altogether metric, and then the old books would all find their way to the paper mill.

The engineers' pocketbooks would also have to be reprinted in the transition language, and then many years later completely metricised. Every present owner of one of these pocketbooks, if the metric system is coming very soon, would have to provide himself with both of the new books, and the transition book would be at least half as large again as the present book, and of course would sell at a higher price. The first editions also would have so many typographical errors and errors of computation that the new editions would sell rapidly.

I concldue this paper with an extract from the appendix of the biparitson report:

The people of the United States have been born and brought up under the English system. It is part of their daily life and habit. No power on earth can force the American carpenter to give up his 2-foot rule. He will not give it up of his own free will. English measures of length are "tied irrevocably to the past." The American people can not give them up if they would.

Even if the metric system were far superior to the English system, which it is not, and even if it were possible to enforce it by compulsory legislation, which it is not, the enormous cost of introducing it, the vast trouble and confusion it would cause during the transition period for at least two generations, the abandonment of our mechanical standards, upon which are based the present system of interchangeability of parts of manufactured articles, the making worthless of the greater portion of our technical literature, make the price too great to pay for any advantage, real or supposed, of the metric system.

(Thereupon the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES.
Washington, D. C., Thursday, March 31, 1904.

The committee met at 11 o'clock a. m., Hon. James H. Southard in the chair.

STATEMENT OF MR. SAMUEL HIGGINS, MECHANICAL SUPERINTENDENT OF THE SOUTHERN RAILWAY.

The CHAIRMAN. Please tell us who you are and whom you represent.

Mr. HIGGINS. I am the mechanical superintendent of the Southern Railway and I have been connected with the mechanical department

of railroads since 1881, either working in the shops, or in charge of a shop, or in charge of the department, as I went along.

Before entering railroad service I graduated from the Sheffield Scientific School, Yale College, so what I have to say about the metric system I feel is not only from a theoretical standpoint but from a practical standpoint as well.

The introduction or the use of the metric system in this country was first brought to the attention of the railroads in June, 1896. There are two associations composed of railroad men, one known as the Master Mechanics' Association and the other known as the Master Carbuilders' Association. They have an annual convention during the month of June each year, and it was at one of these conventions that the matter first came up. I think I was the member of the convention that brought the matter up on account of some bill that was then before Congress which I had heard of. The membership of these two associations comprises a very large majority of the railroad mechanical officers in the United States, Canada, and Mexico, and one of the principal objects of each association is to bring about the use of standards in connection with locomotives and cars—particularly in the case of freight cars. Freight cars, as you know, are away from home a great deal.

For instance, a car belonging to the Southern Railroad will spend a great deal of its time on other lines. The object of having standards in the construction of these cars is to facilitate their repairs when they are away from home. For instance, a car may be built and owned by a railroad in California and finds its way over to the State of Pennsylvania. The car inspector going over that car in Pennsylvania will find something missing; for instance, a nut is lost off the end of a bolt. All he has to do is to go to his little storeroom and he will find some standard size of nut in there that will fit that bolt. He applies the nut to the bolt and the car goes on and there is very little delay to freight. Now, if we had two or three standards for screw threads, for instance, he would either have to carry a large stock or be without the material to repair that car.

The way the mechanical railroad men look at this matter is that the use of the metric system will for the time, at least, destroy all present existing standards. Some men will argue that the change can be made quickly; I claim that it will take at least a century to bring about these changes, and I base that upon the experience in France, where the metric system originated. In France they still use our system for screw threads. They use it in Germany. And if they have not been able to bring about a complete change in one hundred years I do not see how we can expect to do it.

During this transition period it will be necessary for everybody operating a shop to furnish his workmen with cards that would contain the present English units and the corresponding measurements in the metric system. The workmen have got to stop and lose time consulting those cards. That would all come out of the pocket of the employer.

I understand the claim has been made that if we had the metric system in use we would be in better shape to sell our machine tools that are made here to other countries. During the present week representatives of the largest machine-tool manufacturers in the United States, on account of the Southern Railway placing an

order for machine tools amounting to about $200,000, have met here in Washington. Owing to this order of the Southern Railroad they have called to see me, and I have taken occasion to talk with these representatives to find out the necessity of using the metric system so as to enable them to better sell their goods to other countries, and they all tell me that there is no need of that at all, that in fact when they get orders for tools to be exported they are not asked to build them to the metric system. And it seems to me that is a very good answer to the claim that we ought to use it in order to increase our export trade in that particular line.

Another objection to the metric system is the fact that in making drawings it is a very easy matter for a draftsman to misplace the decimal point. It is a very hard matter to catch that in going over a drawing, and as long as that drawing stays in the drawing-room it does not make any particular difference, but let it go out into the shop and you are bound to turn your work out wrong and lose money. William Sellers & Co., of Philadelphia, at one time established the metric system in their shop. They manufacture machine tools, injectors for the railroads and other people. They found that it was very objectionable and gave it up and have gone back to the English system.

The CHAIRMAN. William Sellers & Co. now manufacture their injectors, do they not, by use of the metric system?

Mr. HIGGINS. Yes, sir.

And to conclude what I have to say I would make this statement: That I have read over the literature on this subject rather carefully, and as near as I can figure it out the practical men of this country, the practical mechanical men or the practical mechanical men with theoretical training, are opposed to the use of the metric system, while the purely theoretical men, the men that have not had the shop experience, are in favor of it.

The CHAIRMAN. Now, Mr. Higgins, do you think there would be any advantage in having the decimal system of weights and measures if we could have it in general use?

Mr. HIGGINS. If you could bring about that change in a month or a year I think I should favor it; but it can not be done in that time.

The CHAIRMAN. There would be some advantages coming to the people generally from the universal system of weights and measures, would there not?

Mr. HIGGINS. There would. There would be advantages if we had a universal language, which Mr. Hardwick spoke to me about a little while ago.

The CHAIRMAN. Well, you would consider that the advantages would be very great if we could have a universal system of weights and measures?

Mr. HIGGINS. I do; yes, sir.

The CHAIRMAN. Are you familiar with what is taking place in England looking toward the adoption of the metric system during the last few years?

Mr. HIGGINS. No, sir; I am not.

Mr. HARDWICK. Could you tell us what the practical effects of business, from a financial standpoint, would be under railroads would be to make such a change?

Mr. HIGGINS. It would mean an immense outlay for them financially.

Mr. HARDWICK. How, and why?

Mr. HIGGINS. For instance, our shops are all supplied with standard tools, such as taps and reamers, hand tools and machine tools, that have lead screws for cutting threads according to the English system.

Mr. HARDWICK. Would it be necessary to discard those tools?

Mr. HIGGINS. It will be necessary to discard all of your taps and reamers; you could not revise them, as it were, to suit the metric system.

The CHAIRMAN. Right on that point—you say that when you manufacture tools or a machine, or whatever it may be, for the export trade, where they go to countries where the metric system is used, it is not necessary to make any changes?

Mr. HIGGINS. No, sir.

The CHAIRMAN. Then why would it be necessary here?

Mr. HIGGINS. The reason is that those countries are not using the metric system for their screw threads, and they never have.

The CHAIRMAN. There is no country that uses exclusively any system of screw threads?

Mr. HIGGINS. I think the United States does. I know in railroad practice we do.

The CHAIRMAN. I notice that the booklets we get here, advertising booklets, we find three or four, and sometimes more, standard systems of screw threads mentioned.

Mr. HIGGINS. They are mentioned, but they are not in use. For instance, there is the Whitworth, there is the Sellers standard, and there is the Franklin Institute standard; but the Franklin Institute is the standard of the railroads of the United States.

Mr. BROWN, of Pennsylvania. If screw threads are ordered now they do not specify what kind they want?

Mr. HIGGINS. Not at the present time; the screw threads would be the Franklin Institute standard, or, another name is the United States standard.

Mr. HARDWICK. Do I understand you that if the metric system was adopted these firms abroad that order from firms in the United States would still order their machine tools on the English system?

Mr. HIGGINS. Yes.

Mr. HARDWICK. If that is true, and we adopted the metric system, why would you not still use the English system?

Mr. HIGGINS. I think that would be the result; we would have a dual system the same as they have in France.

Mr. BROWN, of Pennsylvania. We would have a dual system instead of one system?

Mr. HARDWICK. That is what I wanted to bring out. Abroad, then, they have both systems?

Mr. HIGGINS. Yes; and in South America as well.

Mr. HARDWICK. You think that would be the effect in the United States if we adopted the metric system?

Mr. HIGGINS. Yes; I think it would be.

Mr. HARDWICK. Could you give us any idea, in the way of a guess, as to what the cost would be of making a change, or is that too much to ask you?

Mr. HIGGINS. It would be a very wild guess; I would not hardly like to say what I think that would amount to, but the first thing we would have to do would be to start in with our present machine tools, our lathes, for instance, and change their gearing and the lead screws to those lathes to suit the metric system, and from that we would have to take up our taps and get them changed.

Mr. BROWN, of Pennsylvania. Mr. Higgins, you referred a moment ago to the question of possibility of mistake in the use of the decimal.

Mr. HIGGINS. Yes, sir.

Mr. BROWN. Is not that the easiest thing to make a mistake in in all calculations?

Mr. HIGGINS. Yes; it is.

Mr. BROWN. The decimal point is probably the most absolutely elusive thing a man can handle in making calculations.

Mr. HIGGINS. Yes.

Mr. HARDWICK. And the hardest mistake to detect?

Mr. HIGGINS. It is hard to catch it; yes.

The CHAIRMAN. Is it in ordinary measurement where the decimal would increase or decrease the length or weight ten times; would not that of itself be something that would lead to discovery?

Mr. HIGGINS. No, sir.

The CHAIRMAN. In any ordinary weight or measurement?

Mr. HIGGINS. I think not, for the reason that unless that was discovered in the drawing room where, as I say, it is very hard to catch those mistakes, the workmen in the shop are trained to accept drawings sent to them as being correct; they are not asked to criticise those drawings, but are asked to work to those drawings, absolutely.

The CHAIRMAN. But comparing the drawings with a stated measurement, would it not be almost sure to be discovered?

Mr. HIGGINS. No, sir; for the reason that the drawings are not always made to scale.

The CHAIRMAN. Well, wherever there was a statement as to dimensions, it would be made to some scale, would it not?

Mr. HIGGINS. No, sir; it is quite a common practice now, and it saves time, to prepare what we call a tabulated drawing. We show the general outline of the piece, and there may be that same general outline for a number of different sizes. Then in a table we give the length or the diameter, and so on for the different sizes.

The CHAIRMAN. Did you ever hear of anyone who is familiar with the metric system—who is accustomed to work in the metric system—ever complain of mistakes or of liability to mistakes by reason of displacing the decimal point?

Mr. HIGGINS. Yes; that is one of the points raised by William Sellers & Company against its use. That was one of the troubles they had. Some years ago I talked that matter over with their superintendent, and that was one of the points he brought up. It cost them a great deal of money.

Mr. BROWN. In your experience as a workingman, to change the measurements from an inch, or a foot, or a yard, or a mile, or a millimeter, or a meter, or a kilometer, in the case of mistakes, what would be the effect?

Mr. HIGGINS. Well, in the first place it would be very confusing to our workmen.

Mr. BROWN. Would it not take a good while to educate a man to familiarize himself with those terms?

Mr. HIGGINS. Yes; you have to start in educating the boys going to school now. You could not expect to get results from trying to educate men, many of whom are over 40 years of age, and who do not take kindly to that sort of treatment.

The CHAIRMAN. In a decimal system, when you have a denomination or weight stated as one denomination, you have it stated in another when you understand the system?

Mr. HIGGINS. Yes, sir.

The CHAIRMAN. So how could that be confusing?

Mr. HIGGINS. Because they do not understand the system.

The CHAIRMAN. Oh, it would be confusing until they became familiar with it?

Mr. HIGGINS. You would have to provide them, as I have said, with these cards to refer to.

The CHAIRMAN. That is in matters of translation?

Mr. HIGGINS. Yes; and in fact you would have to do that at first to get them familiar with the system; you would almost have to have a school in your workshop.

The CHAIRMAN. There are institutions in this country where they use the metric system. Do you know of their making complaints of those things? For instance, there is the Waltham Watch Company; they use the metric system exclusively.

Mr. HIGGINS. I have not heard of any complaint; but I would think the metric system would be adapted to that kind of business where the measurements are small.

The CHAIRMAN. Do you understand that in Germany or France, or any of those countries where it is used, that they object to it for that or any other reason?

Mr. HIGGINS. No, sir; I do not.

The CHAIRMAN. So, do you not think it is very largely a matter of becoming familiar with it?

Mr. HIGGINS. It is a matter of education.

The CHAIRMAN. It was only introduced in Mexico a few years ago, and they have only had it in use a few years. Have you ever been down in Mexico?

Mr. HIGGINS. No, sir. They are building a railroad down there at the present time, across Mexico to the Pacific coast. I know a gentleman who is in charge of work down there, and I know that they are not following the metric system in their work.

Mr. BROWN. Do you not think that the abolition of our standards of the English system would make great confusion; that is to say, if there was anything in the metric system that was parallel with those things that you would find in the English system, and point that would agree with the standards of measurements we have to-day; in other words, as we know it there is no point in the decimal system that can be well expressed by an inch. It is 2.54 centimeters, I think.

The CHAIRMAN. That is, is there no exact equivalent?

Mr. BROWN. I could not say; I am not very familiar with that idea, but an inch is 2.54 centimeters, I understand.

The CHAIRMAN. Twenty-five millimeters.

Mr. BROWN. Do you not think, Mr. Higgins, that the Waltham Watch Company, whose measurements do not run to inches, could

use the metric system to much greater advantage than those who have larger measurements?

Mr. BROWN. Anything that has a standard over an inch would be at a disadvantage over the metric system?

Mr. HIGGINS. I think so.

Mr. BROWN. Whereas one working in small dimensions might use it to advantage?

Mr. HIGGINS. Yes.

Mr. HIGGINS. Yes. I would like to call your attention to another fact. In a shop often each workman is provided with a 2-foot rule. He can measure 1 foot or 1 inch and keep on dividing by two, and that is a very simple proposition; he had 2 feet or 2 inches or an inch, half an inch, a quarter of an inch, an eighth of an inch, a sixteenth, and so on, and he does not have to make big jumps, but he goes down gradually, whereas in the metric system you would have to go by steps of ten?

The CHAIRMAN. As a matter of fact, would you not take the meter and halve it and quarter it, and so on, in the same way?

Mr. HIGGINS. Yes.

The CHAIRMAN. You could take half a meter and then a quarter of a meter?

Mr. HIGGINS. How many inches would that be?

The CHAIRMAN. It is not a matter of translation now. I am supposing the system to be in use; I am assuming that we would be using meters instead of yards and feet.

Mr. HIGGINS. Do they do that in France?

The CHAIRMAN. I understand so.

Mr. HIGGINS. I think not.

The CHAIRMAN. I was reading a lecture by a former chief of the Coast and Geodetic Survey the other day in which he says that in this matter of subdivision where the decimal system is used it appears they subdivide the same way we subdivide our foot—that is, in metric units like a millimeter or centimeter, or whatever unit they use, they subdivide it the same way where it is more convenient to do so.

Mr. HIGGINS. That may be so; but it was not my understanding of it.

The CHAIRMAN. The subdivision is not something that any system has a corner on.

Mr. HIGGINS. I think there is a big difference between having the English system and the metric system.

The CHAIRMAN. Do you not think that some of the prejudice that arises against the metric system and some of the indisposition to change, results from the fact that, as a rule, we know nothing about the metric system, or little about it?

Mr. HIGGINS. Possibly so; but I have yet to hear of any good reason or any benefit that would come to us from making a change, and I do not believe in making a change simply for a change, without any good reason for it.

The CHAIRMAN. Supposing England should adopt it, what effect would it have upon us?

Mr. HIGGINS. If they followed it as they have done in France and Germany, I do not see that it would have any effect on us.

Mr. BROWN. Would it not be to our manufacturers' advantage?

Mr. HIGGINS. To have them change?

The CHAIRMAN. Yes.

Mr. HIGGINS. It certainly would not be to our disadvantage. I know that to-day the machine-tool makers of this country are taking orders and shipping machine tools to England in large quantities, not because we use the English system, but because we make a better machine tool than they can make.

The CHAIRMAN. Do you represent the Master Mechanics' Association?

Mr. HIGGINS. Not at this meeting; no, sir. I simply come here as the representative of the Southern Railroad Company. I will say that the Master Mechanics' Association and the Master Carbuilders' Association have had this matter up several times since 1896. In fact, they had it up last June. A paper was then read by one of the members at both conventions, and after the reading of the paper they passed a resolution, or had a vote or something of the kind—I don't remember the exact wording—but at any rate the sense of the meetings was opposed to the use of the metric system.

The CHAIRMAN. In each association?

Mr. HIGGINS. Yes, sir.

The CHAIRMAN. How would this bill affect your railroad?

Mr. HIGGINS. As I understand the bill it provides for the use of the metric system by the Government only, but it seems to me that that would lead up eventually to the standardizing of the metric system for the country, which would make it necessary for us to use it.

Mr. CHANDLER. It makes it a legal standard in the United States?

Mr. HIGGINS. Well, that means eventually we would have to use it.

The CHAIRMAN. It uses the word "legal." Have you anything further?

Mr. HIGGINS. I wish to thank you and the members of the committee for this privilege of appearing before you and I hope what I have said will do some good.

The CHAIRMAN. We are very glad to have heard you.

(Thereupon at 11.45, the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, April 7, 1904.

The committee met, Hon. James H. Southard in the chair.

STATEMENT OF MR. OBERLIN SMITH, PRESIDENT FERRACUTE MACHINE COMPANY, BRIDGETON, N. J.

Mr. SMITH. We have a factory at Bridgeton, N. J., employing directly and indirectly about 200 men. Our chief products are presses and dies for working bar and sheet metals, and are sold mostly in this country, but to some extent abroad in various countries of the world. Perhaps one-fourth of our product is exported. Among other things, we made tools to produce coins such as these [exhibiting] for the Chinese and other governments.

In regard to the metric system I have not had an opportunity to prepare a written statement for your committee, nor to give the matter very much study, but I have long felt that it was a difficult subject to deal with. The metric system as it stands is vastly better than the various irregular systems or nonsystems in use for writing and reading and for making calculations of all sorts which involve fractions of units.

If we were going to start entirely afresh in manufacturing, in a new country, I should say adopt the metric system rather than our present Anglo-American one, as the least of two evils, but not because it is at all perfect.

The inherent defects of the metric system, aside from the wrong base for numeration, which I will mention later, are not as great as have been claimed by certain of its opponents. Some have said that the yard, foot, and inch are intrinsically much better units than the meter, millimeter, etc.

That depends upon how we use them. For a good many purposes a meter, representing approximately our yard, is better perhaps than a foot, a foot being too small. In measuring golf links and dry goods and various other things where we now use the linear yard or cubic yards for earth work, etc., the meter would be good enough.

I do not object to the size of the units as far as they go, but I think that we would need another unit with a name of its own smaller than a millimeter. In ordinary machine work the millimeter is not small enough. We have to divide it into hundredths and then we do not get it as small as some of the measurements require.

Probably the "micron" (thousandth millimeter), already introduced for certain scientific work, would answer for anything we expect to do in practical engineering.

In the English measures we do not begin to have that facility of calculation that we do in the metric. This, however, is not because of the metric units or their divisions, but because it is a decimal system—as is our American coinage. It is that we are using a perfect hotch-potch. We have all kinds of measurements for weights, which are extremely confusing, many different ones having the same name. We have the avoirdupois pound and ounce, and various other sorts of pounds and ounces, the grain, in fact, being our only definite unit. We have the furlong and mile and other things, none of which contain round numbers of yards or feet. Then the surveyors are given to using tenths of a foot, because it is more convenient in their calculations, while the rest of us use 12 inches for a foot. When we come to measure capacity we have all sorts of barrels and all sorts of gallons and no definite system of subdividing—some decimal, some binary, and some nothing at all.

Starting afresh we can not imagine anything worse than the English system. Unless a man is versed in engineering he hardly appreciates all the misery of the situation. With work in ordinary machine shops, and also in carpentry, the natural divisions are halves, quarters, eighths, sixteenths, thirty-seconds, and sixty-fourths. A considerable portion of the work in machine shops is counted in sixty-fourths of an inch, but carpenters generally get no lower than sixteenths. Within the last few years machinists have gotten down to finer work than formerly, and sometimes express their distances in one hundred and twenty-eighths and two hundred and fifty-sixths.

The CHAIRMAN. Has it not become very general to express decimals in feet and inches?

Mr. SMITH. We have now finer measurements than just mentioned, expressed in thousandths and ten-thousandths of an inch, and of course are thereby adopting the same decimal idea which the metric system is founded on, but it often bothers us to divide up dimensions by such an awkward number as 10, in actual work. The idea of binary division seems to go all through practical life. One manifestation appears in making drawings to different scales. It is easy to reduce the scale by dividing in half, and then again to one-quarter, and again to one-eighth size, etc., but it is not convenient to transfer to one-third or one-seventh or one-eleventh. Again, dimensions often depend upon the relation of a circle to its radius, which is always binary. Thus we naturally choose scales of one-quarter, one-half, one-eighth, and so forth.

The CHAIRMAN. But when you get down to fine measurements you have to abandon that?

Mr. SMITH. Yes, sir; because it gives awkward vulgar fractions to deal with. I have had shop drawings figured in two hundred and fifty-sixths, but that was not fine enough and we drew the line against five hundred and twelfths. In later years most shops have come to the decimal division of the inch in cases where sixty-fourths are not fine enough. Thus there are usually two systems in the shop, both going on at once. This, however, does not involve duplicate tools, as everything is based on the inch.

If there were no tools to be altered we mechanical engineers might not object to the metric system as the least of two evils, but the tremendous expense involved altering the tools of the numerous machine shops throughout the land, amounting to millions and billions of dollars, and the time it would take to make the change is, in my opinion, too stupendous a task to undertake. Practically, if this bill passes, all the shops will go on using the same measurements and working the same tools as now, except in a case where they make and build an entirely new machine. Very likely for half a century to come they would be working on two systems side by side, with great expense and great confusion.

The CHAIRMAN. That depends very largely upon the rapidity of the change.

Mr. SMITH. The tools we now have will last fifty years as well as one year, because we have master tools that govern others. They are simply used to check up the working tools to see that they are in order.

The principle of binary division is shown everywhere in common life. A woman buys a peck, a half peck, or a quarter peck of potatoes. Such division is easily thought out. You can not easily divide a peck into five or seven parts. You can easily divide it into two or four, and we see this notion carried out in dividing the bushel and the gallon down to the pint and gill. The idea of binary division is natural to the human mind. It is the practical way to do all mechanical work, whether it is cutting into equal pieces an apple, a strip of paper, or a rod of steel.

Now, the whole trouble is that the world started wrong in its numeration. As a vast improvement over everything previous the

Arabs invented the decimal, using ciphers to fill up gaps as the digits were promoted to higher values. It was very ingenious and beautiful, but, unfortunately, they chose for a base or radix the number ten. I suppose they did it because they had ten fingers; but any other base would have done as well, although an even rather than an odd one was preferable. It is yet too early in the coming supercivilization of the world to expect this reform in our numeration, but there will sometime be a change of base. I do not hope to live to see it. It may probably come within a century or two, and the world will get together, and they will say "We will have to have a new base that will give us all the advantages of the decimal system, and yet of complete binary division." Incidentally there will be a great deal less figuring to do for expressing given values, if we take a larger number and adopt a few more digits. The ideal base number is undoubtedly sixteen.

What we now call 16 would be written with a unit followed by a cipher, as 10 now is. What we call 256 would be a unit and two ciphers, as 100 now is. All our numbers would be expressed and calculated with less thinking and writing. Sixteen is absolutely capable of binary divisions down to unity with no fractions, as in the case of 10 and most other small numbers. Incidental advantages would be that it and its square root are perfect squares and its half is a perfect cube. We could not expect a tremendous and radical change like this unless there was a change throughout the world, but my point is that we had better not go to the enormous expense of changing our tools until we can make the great change I have indicated.

My idea would be to get an international commission of scientific men (academic and practical) and let them take their time—years, if necessary—to perfect an ideal mathematical system on the new base of 16, together with a complete system of weights and measures, which would be acceptable to all nations, and then teach it to the rising generation of school children. I would have them study this system just as they study Greek or trigonometry, as a matter of mental discipline. Thus in ten or twelve years we would have a new generation ready to put it into practice as fast as Government authorities and men of science and of business could use it.

Mr. BATES. Is not that just the trouble? Would the practical men of the age accept the findings of scientific men?

Mr. SMITH. I beg your pardon, we engineers profess to be both intensely theoretical and intensely practical. There is no theory worth having which has not been verified by practice, and there is no practice that is worth anything unless it is based on correct theory. Let the commission in question be composed not only of mathematicians and other scholars but also of practicing engineers. Perhaps the only move that could be made now would be for Congress to appoint a commission to act with a joint international commission, could such be created, by having all other countries invited to participate.

Even if we do adopt the metric system (as what I think would be a temporary measure) it would be well not to make such a change now, unless England and the other nonmetric nations do it also. They are now mixing up the system in France with inch-derived screw threads, and thus do not seem to find it wholly adapted to modern manufacturing.

The CHAIRMAN. Your idea is that because of this change we ought to postpone an attempt to get a universal system of weights and measures?

Mr. SMITH. I do. This seems theoretical, but as a practical man I would avoid the great trouble that the change will make and the enormous expense, and this to get but an imperfect system after all. We all know how it has happened with our decimal dollar—12½-cent shillings or "levies" and 6¼-cent "fips." That was from binary division. It seemed to be the natural thing to do, and any decimal system is subject to such trouble.

The CHAIRMAN. That system lends itself to binary division or subdivision with almost equal facility?

Mr. SMITH. It does for the first halving, of 10 into two fives; after that you can not divide into two whole numbers.

The CHAIRMAN. But you take a meter, you can halve it or quarter it?

Mr. SMITH. I beg pardon; you get into fractions very soon.

The CHAIRMAN. Take the millimeter. You say that is not a sufficiently small unit?

Mr. SMITH. Yes, sir.

The CHAIRMAN. Would there be any objection to halving that or quartering that or subdividing it in any way that you would subdivide the inch?

Mr. SMITH. If you are going to change the system and divide the decimal units in halves, etc., you have two systems, and you have many places of decimals or else a mixture of vulgar fractions. I would not do that. If I did adopt the metric system I would stick to it. I would have the comfort of easy calculation, and I would put up with the discomfort of having all my measurements or work expressed in long decimals up into thousandths, ten thousandths, and so on.

The bill we are considering embodies the glaring inconsistency of excepting from its provisions the measuring of public lands. Possibly its author was less familiar with machinery dimensions than with those of land, or he would have made his exceptions cover linear measures of all kinds. As a matter of fact, however, the metric system would make sad confusion with all our land records; our 25-foot and other city lots would be described in complicated figures.

In regard to other measures than linear, I do not see any reason why, if it is desirable, and especially if Great Britian should join us, we should not adopt the metric system for weights and measures of liquids. There are very few tools to change and that would be a small matter.

Mr. LANNING. Both liquid and dry?

Mr. SMITH. Yes; loose materials in bulk, which can be measured as can liquids. But in undertaking to measure the cubic contents in a stone wall or the volume of an excavation, etc., we would have to use cubic, based on linear, measure. So also in selling land and cloth and everything rated by areas. These, also, must be based on whatever linear units we decide to use. Bulk-measuring tools can be very easily changed. It is little trouble to have the tin man change his quart or gallon cups or the scale makers their weights and beam graduations—that is, in comparison with the accurate measuring tools and cutting tools of the engineer.

Mr. BROWN. Would that include the avoirdupois or only where you run to tons?

Mr. SMITH. We have 2,240-pound tons, and we have 2,000-pound tons, and the French ton is somewhat different. We are constantly bothered to know what kind of a ton we are talking about. We have all sorts of perches of stone in New Jersey, 16½ feet and 22 feet and 24¾ feet—with perhaps more to hear from.

Mr. LANNING. I live in New Jersey, and I never heard of 16½ feet being a perch.

Mr. SMITH. It is often so in south Jersey.

Mr. LANNING. Sixteen and one-half cubic feet?

Mr. SMITH. Yes, sir.

Mr. LANNING. Instead of 24¾ feet?

Mr. SMITH. Yes; that is two-thirds of 24¾. I do not know how far this extends, but it is common in the southern part of the State. The irregularity of our weight and bulk units is very confusing. I would not mind seeing the metric system introduced for these as a partial, and perhaps temporary, matter until some day when there will be a complete system of international standards.

The CHAIRMAN. I infer from your argument that you think it would not be a very difficult matter to introduce the metric system commercially if it was not for the manufacturing difficulty that comes in.

Mr. SMITH. I do not think it would be very difficult. I have not studied that point exactly. I do not know how much trouble it would be to the merchants and customers. It is the manufacturing end that I am talking particularly about.

The CHAIRMAN. What do you know about any effort being made to introduce this system in England?

Mr. SMITH. I am not familiar with what is being done there, but I understand that a good many people are in favor of it; I do not know what proportion.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
Thursday, February 2, 1905—11.10 a. m.

The CHAIRMAN (Mr. Southard). We have with us Mr. Raynal, Doctor Bell, and some others, and I think we had better proceed and see what they have to say. Mr. Raynal, I think we will hear you first, if you are prepared. Please give our full name.

Mr. RAYNAL. Alfred H. Raynal.

STATEMENT OF ALFRED H. RAYNAL, MECHANICAL ENGINEER, BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, WASHINGTON, D. C.

The CHAIRMAN. Where are you employed, Mr. Raynal, and in what capacity?

Mr. RAYNAL. I am employed in the Navy Department, in the Bureau of Steam Engineering, as chief draftsman.

The CHAIRMAN. I will ask you if you are a practical engineer?

Mr. RAYNAL. I am, sir. I have served my time as machinist abroad. I have worked as a practical engineer on a trans-Atlantic

liner. I have worked as machinist in the city of New York, and have been draftsman, constructing engineer, and superintendent, building general machinery of almost all classes.

The CHAIRMAN. I would like to have you state to the committee what positions you have held and with what concerns or enterprises, just in order to get some idea of the kind and character of experience that you have had.

Mr. RAYNAL. I have been superintendent for the Wheelock Steam Engine Company, of Worcester, Mass.; Poole & Hunt, of Baltimore; the John Cooper Manufacturing Company, of Ohio; general superintendent of the De Lamater Iron Works, of New York; general superintendent of the Richmond Locomotive Works, of Richmond, Va.; general superintendent of the Corliss Steam Engine Company, of Providence, R. I., and general superintendent of the Walker Manufacturing Company, of Cleveland, Ohio.

The CHAIRMAN. We have under consideration here a bill which provides, in general terms, for the use of the metric system of weights and measures in transactions that govern the use of weights and measures, and the question is as to the advantages or disadvantages to come from the passage of the bill. It provides for the use, as I have said, of the metric weights and measures in the department of the General Government, and I will ask you if you are familiar with the weights and measures of the metric system or what is known as the metric system?

Mr. RAYNAL. I am, sir.

The CHAIRMAN. And as to whether you have used it in your work.

Mr. RAYNAL. I have not only used it, but I use it more or less constantly now, due to the fact that in the course of my regular business I have to read a great many foreign papers relative to the construction of ships, and especially their machinery. The French and other foreign papers give all their measurements in the metric system, and I have to be familiar with it. In addition to that I use it very frequently in my own work, as I find it more convenient.

The CHAIRMAN. You may state what, in your judgment, are the advantages of the metric system over our system of weights and measures, if you believe it has advantages.

Mr. RAYNAL. The discussions on this subject have been published not only through this committee, but through the technical publications, and it has brought forth all of the advantages and perhaps some disadvantages; but the advantages are to the practical men, mainly, not the fact that it is either one or the other length measure, but that the correlation of length and capacity and weight are so much easier in the metric system than they are in our present system that calculations on all such questions as to length, weight, and volume are very much simplified. No doubt you are all familiar with the fact that we deal with feet, inches, and miles, and many other measures. Transposing from one to the other involves invariably some calculation, and at times not an easy one. Knots, feet, and miles, including the statute mile, and all such have to be considered. As to weights we have pounds and tons, we have ounces, and we have different kinds of ounces.

Yesterday it occurred to me that I had to remember that silver is sold by another kind of weight than all the other articles that we buy. It was a trifling article, simply the little silver brazing required for

band saws used in the navy-yards. I had to be very careful to state that troy weight, 12 ounces to the pound, was to be used, when the ordinary avoirdupois weight is 16 ounces to the pound. So we are hampered constantly with this multitude of different terms. In our constructive work we have continually to remember the various units in which it is built. To illustrate, we make the design for a boiler, a marine boiler, say. The details of this boiler are composed of large and small dimensions. In its length or diameter it exceeds the ordinary run of inches, as known in our mind—for instance, we are not familiar with the length of 123 inches, but 10 feet and 3 inches is a measure that we can conceive readily, hence we state the diameter of boilers by feet and inches. The thickness of the shell we state in inches and fractions of inches.

One of the first processes in our consideration is to obtain the sizes of the plates of which this boiler is made, so we take the inner diameter, which we say is given as 10 feet, and then obtain the diameter of the neutral line from which the circumference of the boiler shell is taken. We have to add to the inner diameter one-half of the thickness of the plate on either side, or one entire thickness, say, $1\frac{1}{32}$ inches. You can readily understand at once how awkward this is. This figure we have to multiply with a constant to obtain the circumference. Practically we have to transpose the binary division of the inch into decimals of an inch. Then, after we have obtained that circumference and having determined the number of plates in the circumference, we divide by this number, and thus obtain the width of each plate. This may become $45\frac{3}{8}$ inches, and, the length of the plate being longer than the ordinary conception of inches, we give the length of it in feet and inches and the width in inches—say, a 45-inch plate by 10 feet $11\frac{3}{4}$ inches. The next step is to ascertain the weight of the plate. In order to do this, we have in our mind, as well as in our general tables, the weight per square foot, because the weight per square inch is not convenient.

Now, we have to transpose the length, first, into inches, multiply by the inches of its width, and then divide again by 144 square inches to reduce it to square feet, in order to determine the number of square feet in the plate—mind you, all this time using the decimal system. Then we multiply by the weight of 1 square foot and have the weight in pounds. Now, we want to know the contents of this boiler. We have to know the quantity of water we will have to supply. We have to make deductions of the area for the tubes and all that. We have to transpose again into cubic feet; and, further than that, as that is not familiar to us, and as we do not think in cubic feet of water, we have to transpose again into gallons of water, and, if we happen to have an English publication, we have to bear in mind that the English gallon is materially different from the American gallon. Then we come to the steam space. Remember this is a volume that is to be expressed in cubic feet, while the water was expressed in gallons. I am talking of the conventional figure, because the steam space is brought in relation to the steam used in the engine, which is expressed by the displacement of the piston in cubic feet.

The CHAIRMAN. What I want to get at especially, Mr. Raynal, is this—whether in your work, in your judgment, it would be advantageous to employ the weights and measures of the metric system or disadvantageous.

Mr. RAYNAL. I do not know of any disadvantages that could accrue from the use of the metric system. For the purpose of drawing the designs for a contract I believe it would be absolutely advantageous, for these reasons: It simplifies our calculations, it will be a great saving of time in drawing, and it will be an enormous saving of brain work for the men who figure. While a man figures he is apt to lose the object of his calculation for the time being. Figuring is the stepping-stone to a mental conclusion, and the longer you have to stay on these steps of calculations the farther you get away from the main object. Hence all the devices for mechanical computation.

The CHAIRMAN. Coming back to your own business, I understand you to be the chief draftsman in the Bureau of Steam Engineering of the Navy Department. Am I correct about that?

Mr. RAYNAL. Yes, sir.

The CHAIRMAN. What I would like to know is whether, in your judgment, any considerable inconvenience or loss of time or expense would result from the adoption of this measure.

Mr. RAYNAL. I do not, barring, perhaps, the purchase of a few scales, and in respect to that I would like to call your attention to the fact that the ordinary draftsman now uses a large number of scales. He does not in his drawing practically use an ordinary scale, such as we carry in our pockets, the inch rule, or anything like that. He has to have a sharp edge from which to make his measurements. A very convenient form is the so-called triangular scale. This triangular scale is divided according to different measurements. It has three sides, and on each of those sides there are two different divisions. For instance, one side is marked in inches and eighths of an inch; the other is 3 inches to a foot; another one is half an inch to a foot, representing a quarter scale, an eighth scale; and the other an inch to the foot, and the other a half inch to the foot; another three-quarters of an inch to a foot and three-eighths of an inch to a foot, etc.

The CHAIRMAN. You are speaking now of the triangular scale?

Mr. RAYNAL. Yes; because its section is triangular, and that for convenience. This scale you can use for different drawings without taking up a new scale.

The CHAIRMAN. You spoke about these different steps.

Mr. RAYNAL. On one scale. The French draftsman who uses his scale has but one measurement on it, and that is the millimeter, and with that one measurement he covers all the scales. Our draftsman carries in his pocket a little scale that has at least four different kinds of scale on it, because he makes his general plan on one scale, his detail drawing to another scale, and constantly has to interchange scales. The Frenchman does not have to do this, because he has but one measurement, which by the division or multiplication of ten or other simple numbers is very easily transposed.

Mr. BROWN. Do the French have anything to do with the binary system?

Mr. RAYNAL. Not that I know of; they do not use that.

Mr. BROWN. They do in this country. Where does the Frenchman make it meet the binary system?

Mr. RAYNAL. He does not require the binary division.

Mr BROWN. Would he have to if he had to reconcile it to the binary system at any place?

Mr. RAYNAL. If the transformation of one system to the other is desired, of course he would have to use the proper scales.

Mr. BROWN. Could draftsmen in this country use the French scale alone in their practical work?

Mr. RAYNAL. Most assuredly; just the same as the ordinary machinist uses the inch with the decimal division.

Mr. BROWN. Well, if he had to lay out a draft how would he reconcile it to the binary system?

Mr. RAYNAL. He can take his measurements from that drawing just as easy with the metric system. Let me make this clear to you. If I am to reproduce this chart, it matters not whether I measure it with a scale of feet and inches or yards or with a scale of the meter. You can measure that stick of wood just as readily with this metric side of the rule as with that inch side. Very frequently when something comes up that I want to measure or to make a calculation on, I find it more convenient to measure with this metric side of the rule. Understand me, any system, metric or decimal, will not do away with any binary division. When you give a man 25 cents and say "Here is a quarter," he understands it perfectly clear.

Mr. BROWN. Certainly; and when you say "Here is an inch," how do you express it in the metric system?

Mr. RAYNAL. I take the nearest expression to it, which is twenty-five——

Mr. BROWN. Would that be correct?

Mr. RAYNAL. What is correct, a pound? If you go into a grocery store and ask for a pound of coffee, is that pound correct? It is owing to what you mean. Let me illustrate: If you go into a blacksmith shop and ask to have a piece of iron cut off 1 inch long, the smith takes out his rule and cuts it off approximately; but if you go to Pratt & Whitney to get a piece of iron 1 inch long they will probably measure it ten or fifteen times, because their inch means within certain limits, and the degree of exactitude covers a large range of expenditure. It goes so far that some particular manufacturers of gauges have three distinct systems of calipering gauges—A, B, and C to one-half of a thousandth, the other one one-tenth of a thousandth of an inch, etc.

Mr. BROWN. When I go to Pratt & Whitney and buy a gauge for an inch, I get an exact inch.

Mr. RAYNAL. That depends upon what degree of exactitude you want.

Mr. BROWN. To the absolute degree.

Mr. RAYNAL. They will ask you what degree you want.

Mr. BROWN. I could go to Brown & Sharpe's and get it to one ten-thousandth part of an inch.

Mr. RAYNAL. That is, they are very accurate.

Mr. BROWN. As accurate as can be made. They will subdivide it so it will be absolutely correct. They have a gauge there that subdivides the inch into 10,000 parts, and that inch must be perfectly exact.

Mr. RAYNAL. For that purpose. It is an old saying that a boiler maker's foot is within 9 inches.

Mr. BROWN. Would you arrive at any more exactness with the metric system than with any other? Have you a meter any more exact than an inch?

Mr. RAYNAL. It depends on the measurement required; it has really nothing to do with ordinary measurements.

Mr. BROWN. If you reconcile an inch to meters would you have two inaccuracies? Wouldn't you have an absolute inaccuracy in the inch and an inaccuracy in the gauge?

The CHAIRMAN. I suppose you are talking about the relation, one scale to the other. In ordinary measurements I suppose no such absolute exactness is expected or required?

Mr. RAYNAL. No; it is not. I have here a table of bolts. An inch bolt measures accurately 25.4 millimeters. That is an exact representation. If we were to call it hereafter 25 millimeters, it would be within half or four-tenths of a millimeter from the exact size of it.

The CHAIRMAN. Do the bolts themselves come that close to the exact size?

Mr. RAYNAL. Not necessarily.

The CHAIRMAN. I mean practically?

Mr. RAYNAL. Practically, not at all. It is like this: If you take the tap, for instance, an inch tap, you measure it on a rule as near as you can show with the ordinary calipers, and it measures an inch; but if you apply the micrometer calipers to it to measure to thousands you will find that it is larger, not accidentally, but intentionally. Every one of the manufacturers has learned that it is better to make his tap a trifle large for ordinary commercial use, because in tapping out the nut it goes on that much easier. They would give you an exact 1-inch die for measurement work if you asked for it, but that will not cut an inch thread. There is a distinction between those two measurements.

The CHAIRMAN. I think you are refining probably a little too much. What I want to get at is, and what we would desire, are the practical advantages to be derived from the use of the metric system of weights and measures in preference to the other, if there are advantages; and if there are disadvantages to come from the use of these weights and measures we would like to have you tell us what those are.

Mr. RAYNAL. The advantages are, as I said before, that all our calculations will be materially shortened; that is an absolute fact. The next is that we shall have clearer conceptions of sizes than we have had heretofore. To make that clearer to you, I will say that when we think of binary division, there are very few of us who can conceive readily and clearly lower down on the scale than one-eighth. We all have in our mind the division of half, quarter, and one-eighth of a size. You have to be quite expert and at the drawing board quite a long time to readily conceive of sixteenth divisions, thirteen-sixteenths, seven-sixteenths, or nine-sixteenths. With the decimal system it is very much easier for a man to carry in his mind the subdivisions of 10, just as readily as a man in the store and in the countinghouse can figure 70 per cent or 72 per cent or 30 per cent. You have before you in your mental vision your ten fingers, and there can not be anything easier than that. You take 3 out of 10 or 7 out of 10 or 9 out of 10 and it is perfectly clear to you because you are accustomed to it.

Mr. BROWN. There is no doubt about that at all, Mr. Raynal, that the decimal system is, of course, the most scientific, but the metric system for the larger and heavier work in practical manufacturing

is too small in its units, in my judgment. In other words, the subdivision of an inch in the decimal system is much handier than the subdivision of a meter. For years, of course, it has been the custom in this country to use the present standard.

The CHAIRMAN. Would you be obliged to use the meter as your unit?

Mr. BROWN. What would you use?

Mr. RAYNAL. That would depend upon what you do.

Mr. BROWN. I am talking about the measurements of surface or of size.

Mr. RAYNAL. Take, for instance, in our mechanical drawings, when you speak of small machine work you speak, write, and think in millimeters. When you speak of coarser measurements you think and you speak in centimeters; then when you get to larger dimensions you speak, write, and think in decimeters, and so on.

The CHAIRMAN. When you have a measurement expressed in one denomination you immediately know what it is in every other.

Mr. RAYNAL. There is where the advantage comes in. If it were simply a question of this length or that length, this question, I do not believe, ever would have come up in this country. That is not the advantage of the metric system, whether it is a foot or a meter or a decimeter. The advantage is in the corelations of its calculations and its fitness and adaptability to our present arithmetical notation.

Mr. BROWN. Scientific—well, that is a question.

Mr. RAYNAL. I have been more than once impressed forcibly in my conversation with foreign engineers how much more readily they solve problems of a complex nature—say, volumes of air used for the discharge from an air compressor—questions that I could not answer without paper and pencil. They can do them readily because they have not to divide by this or that number, but they simply strike off decimals. In the metric system we have width, length, thickness, capacity, volume, weight, all expressed in correlated units. The whole thing is absolutely together. It is one and the same thing. It is wonderfully convenient.

Mr. BROWN. Unquestionably; I think the system is convenient.

The CHAIRMAN. Now, we have had men here to speak with reference to this legislation who say that a practical expense and inconvenience will result by reason of the fact that they will be obliged to change their drawings and their tools in the construction of the machinery that they are called upon to make. What have you to say as to that? That is, I mean that that would be the case if this legislation were adopted.

Mr. RAYNAL. That there would probably be some inconvenience and some expense connected with a change I do not doubt for a moment, for a manufacturer would have to buy what he may perhaps not have at present. He may have to buy some rules, measures, scales, and he may have to change his weighing beams. That is a matter really of comparatively small expense when you take the general average expenses of any concern. In addition I would like to say that there are probably hardly any concerns in this country in the machine line that have not an outfit of some kind of metric measurement, because it is constantly asked for.

The CHAIRMAN. What necessity would there be in changing the tools used in the construction of a given machine?

Mr. RAYNAL. I do not know of any. Why should the tools be changed? If I have a planer to plane a piece of metal to one sixty-fourth of an inch, why do I need another tool to do that, simply when I call that thing a millimeter?

Mr. BROWN. Would a different arrangement of sizes—that is, of subdivisions under the metric system—open the door for very much larger specification of sizes than is to-day the custom under the binary system?

Mr. RAYNAL. I do not understand the question.

Mr. BROWN. For instance, you take the Government specifications. The tendency, of course, in all Government work is to make specifications according to the ideas of the engineer who makes the drawings or the specifications. Is he not to-day much more liable to depart from his standard authorities and make them according to his idea as to what they should be—so many thousandths of an inch, for instance, and so many hundreds of an inch—instead of keeping to the old binary system?

Mr. RAYNAL. I do not think so, because it makes very little difference to the engineer, especially to the trained engineer, what you call the sizes. For instance, it is customary to express the diameter of our cylinders in even inches; we have a 60-inch, a 52-inch, a 30-inch, or an 18-inch cylinder. For the stroke we desire to have an even expression; but is that cylinder 60 inches? If you look over our records you will find our cylinder is remeasured afterwards for scientific purposes, and that cylinder may measure $60\frac{3}{64}$ inches.

Mr. BROWN. That, of course, would be so under any measurement and you could not make it any more exact.

Mr. RAYNAL. It is very easy for you to take the nearest millimeter measurement for what is required.

Now, as to the question asked by the chairman in relation to the tools. There is only one tool that might possibly come in question, and that is the threading tool. If a change were made in the threads of screws to a metric system of screws instead of so many threads to an inch, the exact number should be asked for in the centimeter. That would involve a change of gearing, a change of lead screws. But I do not know that such a change is anticipated, nor do I know why such a change should be introduced. More than that, I am personally strongly opposed to such a change. I have been over this whole question when the threads of the United States were changed and the present standard was established by a committee from the Navy Department.

One of the most valuable and interesting documents that we have—and as I happen to have charge of these documents I speak knowingly—is this report, published in May, 1868. It is called for constantly to-day. There is hardly a week goes by that we are not asked for a copy of these standard tables [exhibiting a book]. It is the so-called "Navy standard of screw threads." It was established by the Franklin Institute, and probably originated with the celebrated William Sellers. That particular system has been good enough since that time for us, and is good enough for us to-day, and I hope it will stay with us for a good many years yet.

The CHAIRMAN. There are different systems of screw threads?

Mr. RAYNAL. There are a number of systems of screw threads. Foreign makers have hesitated to adopt the metric system of screw

threads, because if they did they would get into trouble with the Whitworth threads of England and the Navy threads of the United States.

Mr. COCHRAN. That is the standard thread?

Mr. RAYNAL. It is the standard in use all over the country.

Mr. COCHRAN. You say they hesitate to change theirs for fear of getting in conflict with the English, not with ours. Is it uniform with ours?

Mr. RAYNAL. It is not uniform with ours; the Whitworth thread is different.

Mr. COCHRAN. That is the English thread?

Mr. RAYNAL. Yes, sir.

Mr. COCHRAN. What do they have in France?

Mr. RAYNAL. They have three or four different kinds, according to the class of machinery. We have different threads in certain classes of machinery here. We have the sharp, the V thread; we have the rough thread for very coarse bolts in railroad work; but the United States standard is a definite something most generally used. Then we have particular screws, machine screws, and other kinds. They go by numbers.

The CHAIRMAN. Now, what necessity would there be for changing your drawings later on—that is, the markings upon your drawings?

Mr. RAYNAL. I don't believe it would be necessary to make a change, because the people that work in the drawing office can do work equally well with one measurement as with the other. It may be convenient for one certain drawing that is in vogue to-day, and may be used again and again. But to set somebody to work picking out from a table where it says thirty-one sixty-fourths of inch and putting that down in millimeters, if you desire to use it in a millimeter measurement hereafter, is comparatively a slight work.

May I speak here, Mr. Chairman, of a very curious incident? Are you aware that we have in the United States Navy three torpedo boats in which the engines are built by metric measurements? The Bath Iron Works, the contractors for these three boats, bought the plans from Mr. Normand, of France, because this engineer had been so eminently successful with his engines; they proposed and did use his plans to build these engines; but as these plans had to be submitted to the Department the figures on the plans were simply changed from millimeters to the nearest one sixty-fourth of an inch. Where there was a millimeter bolt it was transposed to the nearest bolt in inches or fractions. There was no trouble with it, and the drawings were readily understood. You will find that when you hunt up the sizes of these cylinders in our reports. Where other cylinders are perhaps 18, 25, and 38 inches diameter you read here 17.22 inches and 24.78 inches, and the low-pressure cylinders 37.27 inches; but there was no hue raised that this was something extraordinary.

Mr. BROWN. You say that the nearest variation would be one sixty-fourth. Is that the nearest that can be attained by machine work?

Mr. RAYNAL. No, sir; I am speaking of ordinary sizes. We use very much closer dimensions than that.

Mr. BROWN. In the ordinary sizes of iron and steel they subdivide it down to one sixty-fourth without any trouble. The standard of variation in ordinary sizes is four one-thousandths of an inch.

Mr. RAYNAL. Our divisions, for instance, of twist drills, does not

come closer than one sixty-fourth, and that only up to certain sizes. If I make out a list of twist drills to go as an outfit on a vessel, I use one sixty-fourth, because these have to be tap drills for the nearest size. But up to the inch they are asked for by thirty-seconds, and for an inch and a half by sixteenths, and after that by eighths, just the same as you would observe if you scanned along a line of regular bolt lists. Our bolt lists read one-fourth, five-sixteenths, three-eighths, seven-sixteenths, one-half, nine-sixteenths. Then you have the eighths—five-eighths, three-quarters, seven-eighths, and so on.

The CHAIRMAN. How about twist drills?

Mr. RAYNAL. Twist drills go closer, by sixty-fourths. They have to be, because they have to suit the inner diameter of the thread. When you get to smaller sizes, then you get into the worst abomination that the mechanic has to deal with. Gentlemen, if you had to suffer as we have suffered in the transposition of wire gauges, the American gauge, and this gauge, and that gauge, and have to bear in mind whether that piece of pipe is sold by this man's gauge or that man's gauge, you would never want the present system to continue.

The CHAIRMAN. I would like to ask you what, if anything, the adoption of the metric system of weights and measures would have to do with remedying the situation.

Mr. RAYNAL. It would abolish many of these evils absolutely, and certainly do away with our present system of gauges.

Mr. BROWN. Is the Stubs gauge used to any extent in this country?

Mr. RAYNAL. We use it all the time for certain things. The B-W gauge, we buy condenser tubes and boiler tubes with it. We use it for plates sometimes, but we ought not to use it.

Mr. BROWN. It is disappearing very fast from the iron and steel business to-day because we have two different kinds. They use more micrometer gauges.

Mr. RAYNAL. It is strange to people that have not lived through this period to know how the micrometer gauge has displaced the ordinary calipers. I recall the days when we used to carry our rule in our side pocket along the trousers, and when the first 12-inch steel scales came on the market at a reasonable rate. I recollect very distinctly that glorious American inventor J. Morton Poole, who built the finest machine that was ever designed, and who used to get angry if a carpenter used an ordinary wooden 2-foot rule. He wanted everything measured with a steel scale, and demanded it. After that came the micrometer gauge, and I ask you that use the micrometer gauge if you do not wish there was another division than the present. How much easier it would be if you had a decimal division on the micrometer gauge, than the present one, say Brown & Sharp gauge, with its twentieth of an inch division? I believe my brain is not big enough to grasp it.

Mr. BROWN. It is used practically.

Mr. RAYNAL. We use it by dodging the counting up of the number of thousandths.

Mr. BROWN. That is not the way I have used it, I must say.

Mr. RAYNAL. May I tell you of another experience of interest that is not generally known in relation to the corelation of the decimal with the binary system? It relates to the time when I was with the

Corliss Engine Works. You will remember, probably, that the great inventor hoped to perpetuate his work by building engines in such quantities and so cheap that no one in the world could underbid him. He built machinery and tools that are marvels in their way. And in order to carry out this system he, of course, had to systematize the dimensions of the parts of engines. And he very soon found out that it was not practicable for him to make the fine measurements of an inch in his binary division—the sixty-fourth.

I speak of that as the practical smallest division. Therefore he decided, as at that time the metric system had not arisen to its present use here, to adopt the decimal division of the inch, and it resulted in this curious circumstance. There was a building, I should think, about 150 feet long and 40 feet wide, four stories high, in which the machine parts relating to cylinders, their valves, valve bores, and the governor were built by the inch with the decimal division. All drawings called for it. They were not marked 4¼ inch as the diameter of the valve, but 4.25. The bedpiece to which this cylinder was bolted, however, was expressed in the binary division. There the guides were 28 inches, or so many, and three-eighths. And yet, when the parts out of this shop were taken into the other shop there was no trouble; no mechanic ever asked: "What does the four point two five mean?" Gentlemen, you underrate the mental capacity and the training and the education of the American mechanic if you think he can not understand the metric system. He does understand it.

Mr. BROWN. I do not want to get into an argument about that. I do not underestimate his intelligence, and I do not think I underestimate his indifference with forty years of experience with him. It takes a good while to learn a new trick.

Mr. RAYNAL. Sir, may I say here that I have never found any difficulty in giving a mechanic—I am speaking of machinists here—to give him decimal measurement.

Mr. BROWN. They are bright men.

Mr. RAYNAL. They have it on the scales. The machinist has always carried it. It is familiar to him. The tradesmen offer you, and have offered you for years, little pocket scales that have such measurements on them.

Mr. BROWN. I only want to say that I don't underestimate his indifference—his indifference to learn new things.

Mr. RAYNAL. The indifference extends to all classes of people on this question, and on educational, religious, and legislative questions.

The CHAIRMAN. We are not authorized to sit during the sessions of the House. Now, Mr. Raynal, there are other questions that I would like to have you talk about before the committee, and if you will permit us to designate some other time, we would like to have you before the committee again for a short time. We have with us Doctor Bell, whom we all desire to hear, and he has accepted an invitation to appear before the committee. I think we will be able to hear him a week from to-day; and unless there is some other desire expressed upon the part of the members, the next meeting will be a week from to-day. I hope that you will all be present.

Thereupon, at 12.05 p. m., the committee adjourned.

WASHINGTON, D. C., *February 9, 1905.*

The committee this day met at 10.30 o'clock a. m., Hon. James H. Southard, chairman, presiding.

The CHAIRMAN. Gentlemen, I think we will resume, with the unfinished statement by Mr. Raynal, of the Navy Department. Mr. Raynal, I wanted to ask you a question or two this morning. The first is, How many draftsmen have you in your Department, or in your division?

STATEMENT OF MR. ALFRED H. RAYNAL, CHIEF DRAFTSMAN, BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT.

Mr. RAYNAL. There are about 20—that is to say, 20 in the Bureau here in Washington. Of course there are in the navy-yards others, who are also under the Bureau of Steam Engineering. But in Washington we have about 20.

The CHAIRMAN. There are about how many altogether?

Mr. RAYNAL. I do not know precisely. I should say about 20 or 30 more in various navy-yards.

The CHAIRMAN. About what proportion of your draftsmen are more or less familiar with the metric weights and measures?

Mr. RAYNAL. There are some who have used both systems. Some of them being foreigners, have used the metric system abroad and brought their knowledge of it with them here. And then there are those who have used it here for convenience sake at the desk. They are all more or less familiar with it.

The CHAIRMAN. You say they all use it, more or less?

Mr. RAYNAL. Yes; more or less. That is to say, in their calculations, especially when in their references to foreign data, which comes under their notice at all times, they have to be familiar with the metric system. Then they very frequently use it as a matter of convenience where measurement has to be taken, and it is immaterial by which standard the original measurement is to be taken; and in such cases the calculations become easier in the metric system.

The CHAIRMAN. You understand the substance of this measure, I suppose, known as the Shafroth bill? You understand what it proposes?

Mr. RAYNAL. Yes, sir.

The CHAIRMAN. If that became a law, so that in the transactions of the Government requiring the use of weights and measures you were compelled to use the metric weights and measures, what difficulty do you anticipate, so far as your Bureau is concerned, in the use of the metric weights and measures?

Mr. RAYNAL. I do not think there will be any difficulty. There may be in transposing some of the old data to new drawings. For instance, if a man wants to use a detail drawing from some old ship to make a detailed drawing for a new ship which is to be designed by metric measurements, he will have to do some transposing, some conversion; but that, with the existing tables, offers no difficulty whatever. Then he may for a time, perhaps, be embarrassed and harassed for a while, because his formulas, with which he is familiar, are based on the English measurements. But that need not worry

him, because he can make his original calculations by the old formula and transpose the result.

But that brings up the important point that this embarrassment is for the transition period only. Very soon after that he will commence to think and formulate in the metric system. And that brings up another point, and that is, when he gets to thinking and formulating in the metric system he will abolish a whole lot of old formulæ, which he has been gradually accumulating, some of which are not worth the paper they are written on, and which will have been replaced by new ones. The formulæ exist in the metric system abroad for all our calculations that have been used in machinery, and he will soon learn them.

Furthermore, the so-called pocketbooks, the books of convenience and reference, will contain all the necessary formulæ. As soon as the system is started in this country they will have all the necessary formulæ for using the metric system. So far as making drawings is concerned I think it will be easier under the metric system than under the English system.

The CHAIRMAN. You have some kind of measuring instruments there on the table, I see. What are they?

Mr. RAYNAL. This case [exhibiting same] would very clearly illustrate the point I spoke of the other day. Our draftsmen have to use a great many scales on account of this binary system. This [exhibiting] is what the draftsman uses—an eighth of an inch to the foot, a quarter, three-eighths, half-inch, three-quarters, 1 inch, 1½ inch, 3-inch, and here [indicating] he has got a half size, 6 inches to the foot. And here [exhibiting] he has a thirty-second; and here [indicating] he has an ordinary scale divided in sixteenths.

Now, a Frenchman who is a machine draftsman discards all that. He uses nothing but what is called the "kutch," which is a sort of nickname, and the thing itself is simply a scale with millimeters on it. That answers all his purposes, because the division of scale for which drawings of machinery are made are mostly one-fifth, one-tenth, and one-twentieth, and they are easily read from this scale without any great transposition. He has besides on this a little sliding rule, but that is a matter of convenience to him, and then in addition on the back of this he has printed a list of the specific gravities.

With that instrument he can do all his work, whereas we, under our present system at the present time, need a lot of these scales and tables to get along. We have more scales and make drawings in more different scales than are necessary. I understand in some electrical work abroad the one-third of the scale is used for drawing generators and dynamos and many of the small parts. For that they have a special scale, because that is uncomfortable to transpose from the ordinary scale. But aside from that they use nothing but the natural millimeter scale, and, to my mind, that is of very great importance in making drawings.

Mr. BROWN. Mr. Raynal, are these scales not made in separate ways so as not to have other lines to interfere with the making of the drawings? Are they not so made as to have no other lines except those necessary to mark the different scales for the purpose of measuring?

Mr. RAYNAL. To be sure, Mr. Brown; but it would not be convenient for you to draw from that one-eighth to a foot to one-twelfth. When we come to another field, that of civil engineer, he has another one, in which all that is done in tenths and fiftieths and thirtieths and fortieths and sixtieths. And so we have a lot of scales which, if we had the metric system, we would do away with.

Then there is another point: Our calculations when the inches are given in the inches and binary divisions of the inch, in order to make calculations, have to be transposed first into the decimal parts. We use tables for it. We use slide rules of all kinds. There [exhibiting same] is one kind—the straight slide rule. Then we have a little watch that a man carries along with him. An engineer who has ever had one can not get along without it. There is not a draftsman in our Bureau who does not have this machine [exhibiting same] on his desk. It costs $28. It figures up to about five decimals correctly. He has first to transpose his binary divisions into decimals, and after he has finished his calculations he has to transpose it back onto his paper into the binary divisions. That entails a loss of time and waste of brain work.

I have in my hand here [exhibiting same] a couple of indicator cards. In the indicator cards the engineer has something that is very sacred to him. It is a little chart made by a diminutive piston connected with the steam cylinder, which is the only means we have to know what is going on inside the cylinder, showing the pressure during any part of the stroke; and by it our calculations are made as to the power of the engine, the condition of the valve setting, as to the steam consumption, and so forth.

In our ordinary business we have this lot of scales. [Indicating] I have brought them with me so as to show you what I have to use for this purpose. I have got to have this collection. The Frenchman uses that and nothing else. [Indicating instrument.] That is the fact. That is the plain truth.

The CHAIRMAN. And what do you say as to the calculations? Does one make them as conveniently as others employing the English system to do theirs?

Mr. RAYNAL. Yes. As our notation is based on the decimal system, it must be patent that the decimal calculation is the easier one right straight through. In fact, we are compelled to use it, and do use it, as you can see by that and by the many reference tables we have got. You take this little handbook of Brown & Sharpe. If you take the pains to look into it you will find everything is transposed into decimals. The weights of round bars of wrought iron are given and the diameter is given; the weight here is given as ninety-six point three, etc. The thickness of iron and steel sheets of course is given by the gauges on the one side, but the sizes are given in decimals. A quarter-inch tap drill is given as point 185. I say this to show you that we are compelled to use in this country the decimal system de facto.

Now, a skilled mathematician can set up a number of questions for calculations in which the binary system is of advantage, and, on the other hand, he can make a certain number of calculations in which the decimal system will be of advantage. But that is a mere juggling of figures.

The CHAIRMAN. It depends upon your selection of the problem?

Mr. RAYNAL. Exactly. There are cases where the introduction of the metric system would do away with all binary divisions. For instance, just as you have 100 cents to a dollar, and you speak of a half a dollar and a quarter of a dollar, you would still use those fractional parts, but you do not speak of twelfths or sixty-fourths of a dollar.

The great obstacle, it seems to me, that has been in the minds of the gentlemen who have had this question before them is that they can not, in their minds or in anticipation, get beyond the troubles of the transition period. When you once start, however, you think, see, weigh, measure, and conceive in the metric system; and then you would think it a piece of folly to go back to the other one.

The CHAIRMAN. Have you ever been in Germany?

Mr. RAYNAL. I have, sir.

The CHAIRMAN. What have you observed there with reference to the use of weights and measures?

Mr. RAYNAL. Why, it is universally metric. There is this, however, for convenience sake, or from tradition, or from whatever the cause may be: People may speak of "pounds," but they do not mean pounds. They mean a half a kilogram. For instance, you go into a chocolate store and ask for some candy and you may buy a "pound" of candy, but it is not a pound, but half a kilogram; so that those are conventional terms, the same as we would have if we had the liter introduced here. In that case a great many people would very likely continue to call the half a liter a pint; but for all practical purposes of calculation the measure would be half a liter always.

The CHAIRMAN. What did you observe as to the use of any other weights and measures than the metric weights and measures in Germany?

Mr. RAYNAL. I did not meet any, barring, perhaps, the threads of bolts, because there the English Whitworth thread is retained and the English bolt; and they are sometimes called by inches, because in Germany they have not settled as to the thread and bolt question, and I think it will be some time before they will change it anyway.

The CHAIRMAN. I think you made a statement the other day with reference to what changes in plans for machinery, or what changes in machinery itself, would become necessary, if any would become necessary, by reason of the adoption of the metric weights and measures.

Mr. RAYNAL. You refer to machine tools?

The CHAIRMAN. I refer to any tools of machinery, or plans for tools and machinery that the Government has used in its Departments.

Mr. RAYNAL. Aside from the purchase of some necessary measuring instruments and scales, I do not think it would be necessary to purchase any new tools. In course of time, when certain drills wear out, it may be at the option of a man, and it may be more convenient to get rounded millimeter sizes on hand. That will be, however, an individual choice. But as for the immediate necessity for any change, especially as to machine tools, I am not aware of any whatsoever being required.

Mr. BROWN. Mr. Raynal, the Germans do not use the metric system in land measures, do they?

Mr. RAYNAL. I am not aware of that.

Mr. BROWN. I do not know. Is not that the fact?

The CHAIRMAN. I think they do.

Mr. RAYNAL. I think so. I think they do, just as the Mexicans and the French do.

Mr. BROWN. It seems to me—I have an idea—that there is some confusion in Germany over the fact that they do not use the metric system for land measure, and do use it in the arts and sciences, and that there has been some conflict between the builders and the people in the city of Berlin on that point. I do not know that, however, as an absolute experience. I am not sure of that, but I think that is the case.

Mr. DALE. In regard to that matter, I do not happen to know anything about it in Germany, but I am told that the old French arpent is very common in France.

Mr. BROWN. I think the metric measurement for land measure is not common in Germany.

Mr. RAYNAL. I do not know.

Mr. HALSEY. Mr. Chairman, with the consent of the committee and of Mr. Raynal, when he is through, I would like to ask him a few questions.

The CHAIRMAN. You can do that unless there is some further statement that Mr. Raynal wants to make. Have you anything further, Mr. Raynal?

Mr. RAYNAL. No, sir.

The CHAIRMAN. I judge from your remarks that your opinion is that the transition period will be short?

Mr. RAYNAL. Yes; I think so.

Mr. HALSEY. That is the gist of the whole matter. The metric system advocates contend that that period will be short, whereas the antimetric-system people contend that the transition period will be long. I presume that Mr. Raynal is aware that the first country to adopt the metric system after France was Greece?

The CHAIRMAN. The time for adjournment has arrived, and I suggest that you had better make your statement short.

Mr. HALSEY. Yes. Greece adopted the system in 1836, about seventy years ago. If the transition is so easy and so short surely Greece should use the metric system to-day, but I have here a copy——

The CHAIRMAN. I wish you would not go into any long discussion of that kind, because we are going to adjourn in five minutes.

Mr. HALSEY. I have here a copy of the collected consular reports of last year, containing a report by Mr. Daniel E. McGinley, then United States consul at Athens, on the weights and measures of Greece, and I will read a portion of it. The time is short, but I would like to read this.

The CHAIRMAN. If there is any question you would like to ask, I wish you would do it. But as to the reading of letters——

Mr. HALSEY. My question is, Why are the Grecian people still using their old weights and measures so largely?

Mr. RAYNAL. If you knew anything about their political condition and their country you would not wonder at any condition existing there; one part of their country being for a time in the hands of one set of people, and another part in the hands of another set, just as

you read in the papers the other day about the Turks borrowing their money first from France and then from Germany.

When the German Government decided after the Franco-Prussian war to adopt the metric system and give it a period of trial of two years, it was less than six months before it was in practical use by the market women, by the mechanics, and by everybody; and that satisfied them. And there is not an engineer from abroad—and I meet a great many—who would dream for one moment to go back to the old systems, and who would not think it was the utmost folly, as much so as it would be for us to-day to advocate going back to pounds, shillings, and pence.

Mr. HALSEY. So far as Germany is concerned, I know that in the textile industry at least they do not use the metric system.

Mr. WOOD. When was that system adopted?

Mr. HALSEY. In Germany it was adopted in 1872.

Mr. DALE. A few weeks ago I was talking with a man who came from Germany three months ago, and he could not speak English perfectly, and I asked him the question, "Do they use the metric system in Germany?" And he replied, "Yes; that is the only system they use," but he added, "Aber das Volk braucht die alten Maase." Do you know anything about that?

Mr. RAYNAL. I do.

Mr. DALE. What did he mean by that?

Mr. RAYNAL. He meant that in terms they used it.

Mr. DALE. He said that?

Mr. RAYNAL. He meant that simply as a nomenclature. You should understand that correctly. They do not use the old measures.

Mr. DALE. To prove to me that he did not mean that, he added, "A German mile is 7½ kilometers." What did he mean by that? It is not a metric unit, but it is a German mile. He came from Tilsit.

Mr. RAYNAL. That is naturally the case. The man has known from force of long habit that the distance from Tilsit to the next village, for example, is so many "miles," and he remembers that as that distance.

Mr. DALE. I mean he did not mean nomenclature. He said "Maase."

Mr. RAYNAL. I have made inquiry while abroad as to these statements, as I have read them. They appeared to me as being overstrained. And I have not only made diligent inquiry there, but since that time I have made further diligent inqury as to that. It is possible, for instance, that a certain man who gets a large supply of iron from England—iron plates, for example—and deals with them, may have English inches in mind, or may use English inches, the same as we might, possibly. But however that may be, remember that whenever England or America drops that measure—whichever it is that shall be the first to drop it—when it does so, the binary division of the inch will disappear very rapidly.

Mr. BROWN. Mr. Raynal, did they not have several systems of weights and measures in Germany?

Mr. RAYNAL. Yes. When I was a boy we had in our office a scale, a stick, a yard, or something. That had fourteen sides on it, and each of them had different feet and measures on it. Fourteen is the number, as I recollect very distinctly, and when we made drawings

we had to make a number of scales, one by the side of the other. For instance, if I should make a design of a flouring mill, the building would be measured by the measure in vogue in the city of Hamburg. The bricks came from Hanover, and for them we had another measure, say 9 inches. The timber was brought from Prussia, and that was measured by the Prussian inch or foot. The shafting was brought from England and had the English measurement upon it.

Mr. DALE. Mr. Raynal, do you not think that fact goes to show that a great necessity for a new system, such as the metric system, existed in Germany—a necessity that does not exist here?

Mr. RAYNAL. It was more of a necessity in Germany, but remember they could have made any other measurement a unit just as well. They could have adopted the Prussian or the English or the French. Remember this, please, as I told you the other day: It is not a question, except in a very scientific sense, whether it is this measure or that by which you measure something. That is a minor consideration, and as I told you before, if it were only the question of the meter or the inch, I would stand on the one side or the other. But it is the corelation of capacity and weight and all calculations that correspond to our arithmetical notations. That is the reason why we accept it. And I want to add, we already have the metric system; that is, the United States, France, England, and Germany have in their archives that measurement, which is for all practical purposes good and true. It does de facto work well, unless you want to rake up exceptional cases and make a mountain out of a molehill.

Mr. HALSEY. You claim a superiority for the metric system as based on the fact that the liter of water weighs a kilogram?

Mr. RAYNAL. Yes.

Mr. HALSEY. Can you give an instance where that saves calculation?

Mr. RAYNAL. Why, in any calculation where you want to ascertain a weight of liquid in a cubic volume you must at present have these terrible conversion tables. If you make a boiler you must transfer to cubic feet and gallons and have all these figures in your mind.

The CHAIRMAN. The hour of adjournment has arrived. In fact it arrived a few minutes ago. The committee will therefore stand adjourned to meet again Thursday next, unless we have a call sooner. I want to dispose, one way or the other, of this coinage bill, and I hope we shall be able to get a sufficient number present at our next meeting to take action.

Mr. BROWN. I could not come next Thursday, but I could come on Wednesday. I will be away also on Monday and Tuesday.

The CHAIRMAN. You desire to be present on the day we take action?

Mr. BROWN. Yes, sir.

The CHAIRMAN. We shall try to accommodate you.

(Thereupon, at 11.15 o'clock a. m., the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Washington, D. C., Thursday, February 8, 1906.

The committee met at 11 o'clock a. m.

Present: Representatives Southard (chairman), Dresser, Wood, Knowland, Scroggy, Gaines, Hardwick, and Wallace.

STATEMENT OF HERBERT E. DAVIDSON, ESQ., OF BOSTON, MASS.

The CHAIRMAN. Gentlemen, we have here this morning Mr. Davidson, the president of the Library Bureau. Mr. Davidson will tell us what the business of the Library Bureau is, and will also tell us what he thinks relative to the proposed legislation.

Mr. DAVIDSON. In appearing before your committee, Mr. Chairman, I wish to say that I have not prepared myself by gathering any facts, but come here to tell you in a simple way how we have used the metric system for thirty years in manufacturing and in the various branches of our business. I will preface that by telling you something of the business of the Library Bureau, so that you may have an appreciation of our use of the metric system.

First, we equip libraries with everything they require except books. That means the manufacture of furniture, the manufacture of blanks, of cards, and various appliances which go to equip a library for its proper administration. We equip a library with necessary woodwork, sheet or cast steel stacks, and everything required, except books, so that the range of our manufacturing is iron work, sheet-metal work, ornamental ironwork, a printing establishment, card and stationery manufacturing departments, and several woodworking factories.

The business has grown to such an extent that we have our own machine shops, so that we manufacture our special machinery. It is in these departments that we find not only that it is advantageous, but distinctly an economic thing to use the metric system. All of the work that goes into our different factories which is initiated by ourselves is done in the metric system. We have, of course, a large amount of business that comes to us through architects in which the old system is given—where we have to use the old system—but we use the metric wherever possible.

I find that the gain to us in using the metric system—and this, I think, is perhaps what your committee would like to know—is in laying out work and in putting it through the factory; in the measurements that the men get. A great gain comes in the accuracy afforded by the metric measurements.

For instance, instead of getting a quarter of an inch or a sixteenth "full" or a sixteenth "scant," we have centimeters with exact decimals, and our workmen, some of whom can not read and write, work to these measurements, and work accurately. The advantages that we gain along these lines seem very obvious to us.

Another advantage of the use of the metric system I think I can illustrate in a simple way. In the manufacture of paper stock, all of the paper which the Library Bureau uses is made to metric standards. We take a square meter of paper as the unit. One standard weighs 125 grams to a square meter. Another standard weighs 200

grams, one 300, and another 400 to a square meter of paper. These are the standard stocks which we regularly furnish. When other standards are submitted which we are compelled to match we measure and weigh the paper by the metric system. It requires simply a mental calculation to tell if it is the same as our standard or near it, or if necessary to ascertain the standard under the old system of inches and pounds our calculations are done mentally in the metric system and translated into English. To work through the metric system is a saving of time and mental effort.

The CHAIRMAN. What position do you hold in this bureau?

Mr. DAVIDSON. I am the president of the Library Bureau.

The CHAIRMAN. Is it a corporation?

Mr. DAVIDSON. It is a corporation under New Jersey law. We have twenty-six branch offices scattered throughout the world. We have a large established business in Great Britain, and we have altogether, in different parts of the world, nine factories. We have a factory in Canada, a factory in Chicago, a factory in Boston—several in Boston, in fact—and some in Great Britain. In all of these we use the metric measurements. Our specifications are all given in metric measurements, as I said, so far as the initiative is with us.

The CHAIRMAN. Where do you sell your product?

Mr. DAVIDSON. Largely in the United States and Great Britain, although we send it to all parts of the world. Our business is largely in nonmetric countries, but all our devices are sized by the metric system. For instance, the series of card which we manufacture—$7\frac{1}{2}$ by $12\frac{1}{2}$ centimeters—is the international standard for card cataloging in libraries. The next standard size is 10 by 15 centimeters. That is approximately 4 by 6 inches. The $7\frac{1}{2}$ by $12\frac{1}{2}$ centimeter size is approximately 3 by 5 inches. Another size—$12\frac{1}{2}$ by 20 centimeters—which is approximately 5 by 8 inches, is much used, and so they run on up to 20 by 25 centimeters, which is an approximation to 8 by 10.

The CHAIRMAN. Do you print a catalogue?

Mr. DAVIDSON. Yes; and in all of our catalogues the dimensions are given in the metric system. We have used that system ever since we printed a catalogue; and I would say with regard to the business of the Library Bureau that in 1888 we had four people employed in the business and to-day we approximate 2,500. I speak of this to show that we are constantly bringing in new people, and this is a point which I would like to emphasize: We have never had any novices in our business who did not comprehend the metric system as easily as a boy comprehends our system of money.

The CHAIRMAN. You say you never had what?

Mr. DAVIDSON. We have never had an employee who did not easily comprehend the metric system; and the range of employees is from the workman who can not read and write to college men who have charge of the different departments.

The CHAIRMAN. That is what I would like to inquire especially about—what difficulty they find in taking up and working in the system.

Mr. DAVIDSON. We have never had any complaint; we have never had anybody say, "This is difficult." In all of our manufacturing—machinery, woodwork, ironwork, cards, blanks, and other stationery—

we have never had the least difficulty from anyone making mistakes or from misunderstanding our specifications because of our use of the metric system. Metric rules are given all employees, and the measurements are given them in centimeters and decimals. We, however, use the half—i. e., "7½ centimeters," rather than "7.5;" in the case of 7.3 we would say "seven and three" (written "7 decimal point 3"). That makes it so clear that no one of any intelligence finds any difficulty in following our instructions.

The CHAIRMAN. Have you been using this system of metric weights and measures continuously since you began?

Mr. DAVIDSON. Yes, sir; all of our standards have been based on it from the beginning of our business.

The CHAIRMAN. And your tools are all in metric sizes?

Mr. DAVIDSON. All in metric sizes; all the materials we manufacture have always been in metric sizes.

The CHAIRMAN. What difficulty do you find with the trade in marketing your product?

Mr. DAVIDSON. It is never questioned. Once in a while a man says, "Why do you use metric sizes?" We reply, "Because it is the international system and we sell goods all over the world;" which is a sufficient statement, but it is not the whole reason for our adoption of the metric system. We adopted the metric system because it furnishes better facilities; it is an economical thing to do. My illustration of the matter of paper is just one in point.

Mr. GAINES. Mr. Chairman, right there, a moment, if you please, sir. You say it is an international system, Mr. Davidson. Do you mean that it is the system that your company employed in the selling of your products in foreign countries?

Mr. DAVIDSON. Yes.

Mr. GAINES. You do not mean the United States make it an international system?

Mr. DAVIDSON. No; I meant, perhaps, more—it is an international system; it is the one in use in Germany, France, and continental countries, in all of which we do some business.

Mr. GAINES. It is international with you when you trade with those people?

Mr. DAVIDSON. Yes.

Mr. GAINES. All right, Mr. Chairman.

The CHAIRMAN. Is it not international in another sense—that the International Bureau of Weights and Measures have adopted the metric system as the standard?

Mr. DAVIDSON. Why, I think it is international in this respect, sir—I am not quite certain about Great Britain, but certainly it is permissive to use it here. It is a legal standard of weights and measures in the United States.

The CHAIRMAN. Is it not a fact that Great Britain is a member of the International Bureau of Weights and Measures?

Mr. DAVIDSON. I am not sufficiently familiar with the subject to say.

Mr. MAILLOUX. Yes; both systems are legal in Great Britain. There is no country in the world where the metric system is not legal.

Mr. GAINES. It is not compulsory with you to use it, then?

Mr. DAVIDSON. Oh, no, sir.

Mr. GAINES. But it is perfectly permissive. You have no objection, however, to other people not using it if they so choose?

Mr. DAVIDSON. Oh, no; not at all; but it would be a convenience if other people did use it.

Mr. WOOD. You have adopted this system and have always used it. What would be the special advantage of the extension of the general use of the system?

Mr. DAVIDSON. Do you mean to other people?

Mr. WOOD. To you, if you did use it?

Mr. DAVIDSON. It would do this for us: Instead of receiving our specifications from architects and from engineers in feet and inches, we would receive them in metric dimensions, which would simplify matters. If the system were in general use, all of the material which we buy would be on the metric standard, and we should experience to some extent what a gentleman in New York remarked to me yesterday—that if the metric system was introduced into this country and was in complete use, the concern with which he was somewhat connected would save $50,000 a year in the cost of figuring quantities.

Mr. WOOD. It would be a special advantage to you, however, on account of your international connections, would it not?

Mr. DAVIDSON. No; that would have no particular bearing upon the subject. Our business in this country is with this country and is not affected by what we do abroad. The point is that we are established on the basis of the metric system, and if all of our customers used it it would simplify things for us.

Mr. GAINES. And you want it done as a matter of convenience for your firm?

Mr. DAVIDSON. Well, yes, for one reason. It does affect us materially, as I say, in figuring quantities.

Mr. GAINES. But it would be a great convenience to your firm?

Mr. DAVIDSON. Why, I think it would be a great convenience to everybody.

Mr. GAINES. What percentage of the business of the country do you do in your line of business?

Mr. DAVIDSON. That I can hardly tell you.

Mr. WOOD. Have you any competitors in the business on this side?

Mr. DAVIDSON. Yes; oh, yes.

Mr. WOOD. Do they use the metric system?

Mr. DAVIDSON. They do not, except so far as some of them have adopted our standards.

The CHAIRMAN. You say you employ about 2,500 men?

Mr. DAVIDSON. Yes.

The CHAIRMAN. Where are those men employed?

Mr. DAVIDSON. They are employed in Boston, in Chicago, in New York, and in smaller numbers in different parts of the country. Our operatives are confined principally to those cities where our factories are located.

Mr. WOOD. How many factories do you say you have?

Mr. DAVIDSON. We have altogether nine different factories of one kind and another.

Mr. GAINES. Mr. Chairman, if you and the gentlemen who preceded me are through, I would like to ask Mr. Davidson a number of questions.

The CHAIRMAN. Very well; go ahead, Mr. Gaines.

Mr. GAINES. I was a little late in getting in. Where is your place of business?

Mr. DAVIDSON. Our headquarters are in Boston.

Mr. GAINES. What is your business?

Mr. DAVIDSON. The business of the library bureau, which is a business formed to equip libraries with all that they require except books, and has developed into equipping offices with business systems.

Mr. GAINES. What, now, did you put in the Congressional Library here, or what is in that library which you make?

Mr. DAVIDSON. You will find the large catalogue cases to which you refer when you consult the catalogue in the Congressional Library, for one thing, were furnished by the Library Bureau.

Mr. GAINES. It is not the practical, everyday things of life which you make?

Mr. DAVIDSON. That is a particular case. The practical, everyday things of life we make to this extent—that we manufacture things which go into all the leading offices of the country. We have, for instance, on our books 80,000 customers—80,000 accounts—which represent the people with whom we do business. They are municipal offices and the various departments of such offices—such as assessors, probate offices, and the large field of commercial houses in a city like New York.

Mr. GAINES. Now, my dear sir, will you tell me what business the Departments of the Government of the United States have, in the transaction of business requiring the use of weights and measures, to say that those businesses shall employ and use the weights and measures of the metric system in furnishing private offices and private libraries and private businesses of this country with machinery?

Mr. DAVIDSON. Will you state your question again?

Mr. GAINES. This is a bill compelling the Government of the United States, after 1908, to adopt the metric system. It is compulsory, you see, beginning at that time. What business has the Government of the United States in equipping private offices and private businesses of this country with private machinery?

Mr. DAVIDSON. I do not think——

Mr. DRESSER. There is no attempt to do that, is there?

Mr. GAINES. That is what this bill that we have under consideration is for.

Mr. DRESSER. The Government adopts these standards as standards for the Government; that is all; not for private individuals; not for me as a private citizen. I am not compelled to use that system.

Mr. GAINES. Exactly; and I am trying to get at the relevancy of his testimony to this bill. My friend from Pennsylvania, for whom I have much esteem, will see my point in a minute. This bill is No. 8988, and, leaving out the caption, etc., it reads thus:

> That from and after the 1st of July, 1908, all of the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system.

Now, I will put my question in another way: What business has the Government of the United States in trying to control how I manage my private business, or what I equip my private office with or how I equip it, or from whom I buy it and by what measure I buy it, when

I already have a measure that is perfectly satisfactory to me, and has been for more than a century?

Mr. DAVIDSON. I do not know that this bill in itself has anything particularly to do with the testimony that I have given you.

Mr. GAINES. That is the point I was trying to get at. Now we will go to another question.

You say this is an international system. I believe you have said that it is with your firm; that is the substance of your answer. Will you compare the business of the United States of America with our own people—that is, in our home affairs—with the people of England, France, Germany, Spain, Italy, Japan, or China, or any one of them, and show me to what extent, or on the basis of what per cent, the business international with any one of these countries compares with the business of the United States with her own people or the people of the United States with themselves? I want to show how much is international and how much is local or done within the limits of the United States.

The CHAIRMAN. I do not know that I understand your question, Mr. Gaines. I would like to understand it.

Mr. GAINES. I will put it more briefly, then. I am trying, Mr. Chairman, to get at the immense quantity of international business or the small quantity of international business——

The CHAIRMAN. In his particular line?

Mr. GAINES (continuing). Done between the United States and foreign countries in which the metric system is employed generally or by this particular firm. Is it immense; and if so, to what amount or what per cent? Or is it very small; and if so, to what amount or per cent?

Mr. DAVIDSON. Pardon me, sir; but as I look at the matter, it is a question whether the United States is wise to take such steps toward the introduction of the metric system in conformity with the rest of the world, barring Great Britain, as will tend to bring about the adoption of the system. And, if you will allow me to say so, I am here to-day to bear a very simple testimony to the use of the metric system in ordinary business life; and I wish to say that so far as my experience goes and that of my colleagues, it has been a great advantage to us. Whether the United States ever adopts the metric system in its custom-houses and elsewhere or not, whether the rest of the world adopts it or not, it has been a great advantage to me and to the company which I represent to have used the metric system for the last thirty years. That experience is such that I believe if the rest of the United States would do the same it would enjoy the same advantage.

This bill is perhaps a step, as I look at it, toward the introduction of the metric system in the United States; and when it comes the advantages which will accrue to the United States by reason of the complete adoption of the metric system are enormous. I think, gentlemen, that the extent to which the metric system is already in use in this country is very little appreciated. I happen to be fortunate or unfortunate enough to be interested in some mining property, and the other day one of my men said to me: "I am going to change our screens. I shall substitute a millimeter-and-a-half screen." Others are using the metric system besides the Library Bureau. They are

manufacturing screens for mining machinery on the basis of the metric system, and I run up right and left against cases where the metric system is used. The extent to which the metric system is in use to-day would be a surprise, I am sure, if you knew what it was.

Mr. GAINES. You say this is an entering wedge to get the United States as a Government to adopt the system in a compulsory way, as I infer from your argument (for this bill is compulsory), for all of the people of the United States, and to do away with the present standards of weights and measures, is it not?

Mr. DAVIDSON. I should say that it would have a tendency to make the rest of the public want the metric system, and that they would not be satisfied until they got it.

Mr. GAINES. Yes. If you compel them to do it and impose a penalty, then they must pay the penalty or abide by the law. Do you think that is a wise thing to do, when our people have not adopted the metric system, and when we have been permitted to adopt it as individuals if we choose for, I should say, fifty or sixty years? I think it is about sixty years that we have had that permission, and the Government now has that permission. Do you think it a wise policy to pass a bill here that is compulsory, which is an entering wedge to compel the people to change all their weights and measures and adopt the metric system?

The CHAIRMAN. Do you place that construction upon this bill?

Mr. GAINES. I do not want to argue it, Mr. Chairman. The bill is compulsory, you know, for the Government of the United States, beginning with 1908. The gentleman has very tersely said that that is an entering wedge for the ultimate adoption of the metric system, and cites us to an example where some gentleman is going to change his screen. Now, no one has any objection to anyone taking any measure he chooses; that is the law now; but he says that this is an entering wedge to compel the Government of the United States to do away with its present weights and measures and compel the people to adopt the metric system.

The CHAIRMAN. You talk about the Government at one time and the people at another.

Mr. GAINES. I am trying to compare the two.

Mr. DAVIDSON. Pardon me, sir, I think that inference is not quite warranted by anything I have said.

Mr. GAINES. I will be glad to have you explain exactly what you mean. This is a compulsory bill. Do you think it is wise for us to have a compulsory metric system in 1908 for the people of the United States?

Mr. DAVIDSON. I should think that the United States Government might say to its own employees that at such a time we will use the metric system; but it does not follow from doing that, or from any action it may take on this bill, that two years later or five years later it shall say to the public that no other than the metric system shall be the legal system of the United States. I think that the inference there is not justified.

Mr. GAINES. Let us say, then, that the Government of the United States adopts this system and yet the great body of the people of the United States—I mean about 85,000,000 of them—use the old standards of weights and measures. Do you think it is wise for the Gov-

ernment of the United States, with its immense contracts and its compulsory power and its great money functions and power, to compel the people when treating with it to use the metric system when they do not know anything about it and do not want it; when they do not measure their goods or carry on their businesses with the metric system?

Mr. DAVIDSON. I think that it would be a distinct advance for the Government of the United States to make such a law as this; that it will ultimately save time and money for everyone who has to do with the Government. The metric system itself is so simple that no one need have any difficulty in dealing with the Government or in dealing with its citizens.

Mr. GAINES. I understood you a moment ago, by your gesture on the table, to say, "We lay out before our employees a metric standard, and no one with any intelligence could fail to go by that standard, or, in other words, make mistakes if they went by that standard." Do you mean by that to say that you have to lay out before your employee a picture of the standard so that he or she may go by it all the time?

Mr. DAVIDSON. I referred to the new employees who had never before used the metric system; I simply give that employee a metric rule.

Mr. GAINES. You have to teach him every day—is that the idea?

Mr. DAVIDSON. No; only once.

Mr. GAINES. Well, you have a picture before him every day of the metric standard, from the gesture you made at the table; and that is what I am trying to find out.

Mr. DAVIDSON. You misinterpreted my gesture. I simply show him a metric rule on which are marked centimeters and millimeters.

Mr. GAINES. Suppose in 1908 the United States Government were to adopt this standard; everyone who dealt with the Government would have to be well equipped to know how to deal with the Government by the metric standard, would he not?

Mr. DAVIDSON. To some extent I should think he would.

Mr. GAINES. Do you know of anyone in the United States who deals with the Government of the United States who is using the metric standard, other than your own firm?

Mr. DAVIDSON. Why, a great many concerns use the metric standard. Take the firm of Brown & Sharp—we buy metric rules and gauges of them very frequently.

Mr. GAINES. Do you not believe, Mr. Davidson, that the people of the United States would have, in other words, to go to school, from the youngest to the oldest, and learn the metric system, before they could deal with it and use it? Is not that common sense, and is not that true?

Mr. DAVIDSON. That is just the point which I have failed to make, I see—that with our entire range of employees (all kinds of people such as might be employed in a large variety of manufacturing) we have never had anyone who had difficulty in applying the metric system, after being simply told, "Read your rule." It is exceedingly simple—exceedingly simple in each case.

Mr. GAINES. That does not exactly answer the question, Mr. Davidson. I want to know if everyone, old and young, would not have to learn the metric system before they could deal with it?

Mr. DAVIDSON. I do not think so, sir.

Mr. GAINES. How in the world could I know if you were dealing with me? I confess I do not know anything about it, any more than what I have learned here; when I went to school my teacher very properly, I think, skipped me over the metric system, and they did not teach it then. Would we not all have to go to school and learn the metric system before we would know whether or not we were getting the true measure according to the old standard?

Mr. DAVIDSON. I think that a person of ordinary intelligence who gave five minutes to the subject of the metric system would be able to comprehend it. [Laughter.]

Mr. GAINES. How long have you studied it?

Mr. DAVIDSON. I must say that I never spent fifteen consecutive minutes over it.

Mr. GAINES. Well, you are an expert by nature.

Mr. DAVIDSON. If you will allow, I will explain what I do mean. The metric system simply uses for common purposes three units of measurement—the meter, which is a familiar term to us, signifying measure; the liter, which will be used instead of the quart; and the kilogram (1,000 grams), abbreviated to kilo, for a unit of weight. Those are for common purposes. Now, there is no difficulty in the country store using the metric system, as I see it. The meter is 10 per cent more than the yard. The liter is 10 per cent more than one of our quarts—we have two, now. The half kilo is 10 per cent more than the pound. So that the adoption of the system by the common people in ordinary buying and selling will be a comparatively simple matter. If at some time in the future the public should take it into their heads to do business on the metric basis and adopt the system, Congress not compelling it, I imagine we would find that they were using a new yard under the same old term, of a value of 10 per cent more, and paying 10 per cent more for it; a new quart, which would be the liter; and a new pound, which would be the half kilo, each of which is 10 per cent more in price and in value than the old standard. The change would be no hardship to the common people.

Mr. GAINES. But you would have to teach the people; the people would have to teach themselves, or somebody would have to teach them what a meter meant, etc., would they not, in lieu of a foot and in lieu of a yard?

Mr. DAVIDSON. What was to be used in lieu of a yard?

Mr. GAINES. And in lieu of a pound, etc.?

Mr. DAVIDSON. Yes, sir; eventually.

Mr. GAINES. Now, I do not want to weary the committee with my continuing colloquy; I just want to find out how we are to equip our people with sufficient information to enable them to know how to swap one plan for the other, Mr. Chairman. Then I shall end this colloquy. Where did you learn the metric system?

Mr. DAVIDSON. By putting a rule in my pocket and using it the same as I would a foot rule.

Mr. GAINES. How old were you when you did that?

Mr. DAVIDSON. I should say I was perhaps in my teens.

Mr. GAINES. Thirteen or nineteen.

Mr. DAVIDSON. Well, make it nineteen.

Mr. GAINES. What were you doing?

Mr. DAVIDSON. I was working in an office in Boston.

Mr. GAINES. In what business?

Mr. DAVIDSON. It had nothing to do with my present business. I was in the shoe business.

Mr. GAINES. It was your business to do that, and you were employed to do that. What did you know about it before you were employed upon this metric measurement?

Mr. DAVIDSON. Why, I chose to use the metric system because it impressed me as being simpler.

Mr. GAINES. When did you first undertake to study the metric system?

Mr. DAVIDSON. I say I never studied it.

Mr. GAINES. Until then?

Mr. DAVIDSON. Not even then.

Mr. GAINES. How much of the business of your firm were you intrusted with to measure up at that time? Were you at the head of the firm?

Mr. DAVIDSON. The present firm was not in existence at that time. Bear in mind, sir, that the time when I was in my teens was more than thirty years ago.

Mr. GAINES. I would infer that from one thing, and from another I would not. The people of the United States, at all events, would have to first learn the metric system before they could use it. Now, that is what I am trying to find out—they would have to learn the difference between a foot and a meter and a yard and a meter and a pound and a meter, and so on. They would have to do that, certainly.

Mr. DAVIDSON. They would have to gain some knowledge of the metric system; but it all appeals to me, sir, as being so exceedingly simple that I can not comprehend the intelligence that can not understand what a meter is, what a liter is, and what a kilo is.

Mr. GAINES. But you must remember that we are not all college graduates, unfortunately for us; and I take it that you are.

Mr. DAVIDSON. Neither am I.

Mr. WOOD. The introduction of this system, of course, would not interfere with your business, because you have already adopted this system. But would it not be necessary to make a readjustment in other businesses of this sort, and cause some inconvenience thereby?

Mr. DAVIDSON. There would be a transition period, I imagine, which would be inconvenient to some people—to some more than to others. The whole question, sir, to my mind, is, Is the metric system an economic measure for this country?

Mr. WOOD. Do you think it is a better system for your business and also for the country as well?

Mr. DAVIDSON. I am simply quoting my experience as a representative of the average business of manufacturing and selling in the United States. We represent a large number of manufactures in the type and character of our business. For instance, our woodworking factories represent thousands of woodworking factories. Our metal shops, hundreds of metal shops. Our machine shops, thousands of machine shops. Our card and printing plants, while others may not do exactly the same things that we do, are types of which there are thousands and thousands in this country. Now, they

would have no difficulties that we have not met; and what I am trying to present to you gentlemen is that we find the advantages of our use of the metric system so outweighing any disadvantage that there is in the introduction of the system that we have maintained it, not as a fad, but simply as a wise and beneficial business arrangement—simply as "good business" judgment.

Mr. WOOD. Do you find any special difficulty in the translation of the standard weights and measures to those of the metric system, which you have to do, of course, in your business, as you have the metric system?

Mr. DAVIDSON. We have to do a certain amount of translation of the English into the metric system. As I remarked to the chairman earlier in this discussion, we translate other things into the metric system and retranslate them into English as the quickest mathematical way of arriving at a result. Take the very simple illustration of the weight of paper—perhaps you were not here when I gave it. The paper which we use is on a metric basis, the standard of weight and size. A square meter of paper weighs so much; and to arrive at the weight and the comparison of some other paper with that we translate it into the metric, measure it by the metric, weigh it, and then translate it back into the English, as being the simplest mathematical way of figuring out what the exact standard of the paper is.

Mr. WOOD. You think, then, that there would be a transition period during which there might be considerable derangement of business?

Mr. DAVIDSON. There would be some annoyance; it could not be otherwise. You can not go from one method to another without some measure of annoyance. But from our experience we say most distinctly—it is my most sincere judgment—that it is exaggerated. All the difficulties of the introduction of the metric system into the United States are the difficulties of the unknown, which are always exaggerations.

Mr. KNOWLAND. You are looking to the ultimate result?

Mr. DAVIDSON. We are looking to the ultimate result.

Mr. KNOWLAND. A man moving into a new building suffers some inconvenience while he is moving, but when he gets into the new building that is offset.

Mr. DAVIDSON. The transition period from the old system of weights and measures to the complete adoption of the metric system will entail some inconvenience.

Mr. KNOWLAND. How much in dollars and cents?

Mr. DAVIDSON. I have no measure of that. In our factories $25 would buy all the metric rules we would need if we were changing from the old system to the new. But it is the ultimate result of obtaining a system which will save time and money—save the time of the children in the public schools and save time and mental effort as long as men work.

Mr. WOOD. But would not all the business concerns of the country be put to considerable expense in procuring these new metric measurements and instruments?

Mr. DAVIDSON. Yes. But if the thing is gradual that expense will be at its minimum.

Mr. WOOD. Do you not think that the adoption of the metric sys-

tem of weights and measures for the Government would almost necessarily lead to the general adoption by the people of the country of the same system?

Mr. DAVIDSON. Ultimately.

Mr. WOOD. Otherwise we would have two systems in this country—one adopted by the Government for its own purposes, the other used by the people, and that would lead to a great deal of confusion, would it not?

Mr. DAVIDSON. We have two systems now. The metric system is more or less in use.

Mr. WOOD. But the metric system is not used to any very large extent, is it? It is used by your concern because it has international connections. I suppose it is used by some other concerns. But the common weights and measures are those of the English standard system, are they not?

Mr. DAVIDSON. Yes; but, as I said, you have very little conception—you have no knowledge, in fact—of the extent to which the metric system has permeated the business of this country. I do not recall instances, but I run up against them very frequently.

Mr. WOOD. Please give us an idea as to the extent to which the metric system has already been adopted by the private concerns of the country. I think that would have a bearing upon this question as to whether the Government should adopt it for its own purposes, inasmuch as that doubtless would be the first step to its general adoption by the whole country. Can you give us some idea of that?

Mr. DAVIDSON. It is only an impression received here and there. For instance, you will find that opticians use the metric system. All chemistry uses the system—I mean, commercial chemistry. Druggists in our section of the country use the system to a large extent.

Mr. GAINES. What changes would have to be wrought in the machinery making the goods and output of our manufacturers if we adopted this system?

Mr. DAVIDSON. As to a large part of the machinery of the country manufacturing staples, I doubt very much whether it would need any change at all.

Mr. GAINES. Have you looked into that question? You have never made an estimate of how much it would cost to change our present machinery to what you might term the machinery necessary to be used if we adopt the metric system?

Mr. DAVIDSON. No, sir; I have not.

Mr. GAINES. That is all I have to ask you.

Mr. DAVIDSON. But I would like to answer that suggestion by this statement—that there is no concern in the United States that can not well afford to make the change from the present standard to the metric standard for the advantages which will accrue to it from that change, regardless of any expense that it may incur. I wish to make that statement as my sincere and best judgment so far as my observations have taught me in regard to it.

Mr. GAINES. That observation you make without having investigated it as a matter of fact?

Mr. DAVIDSON. In special instances I have not investigated it. Let me say this, in answer to your suggestion, that a gentleman in New York yesterday (I think you were not here when I made the state-

ment) said that the metric system would save the concern with which he was connected (I do not know whether it is bridge building or what it is, but they have to figure large quantities) $50,000 a year in the expense of making the estimates which they have to make. That is just a sample of what would happen all over this country. You gentlemen have the opportunity to see the other side. To the man who does not know, as I say, the unknown is what he fears. You see and hear that side. What I am here for to-day is to tell you something of the other side. From my experience of what the metric system has accomplished for our concern under no circumstances would I for thousands of dollars a year revert to the English measures.

Mr. WOOD. Is there considerable objection on the part of the business interests of the country to a change from the system of weights and measures at present used?

Mr. DAVIDSON. I do not know.

Mr. WOOD. Have you formed any opinion?

Mr. DAVIDSON. I am not in position to judge as to that. I see articles in the New York Herald to the effect that a good many concerns in New York are in favor of the metric system. I have talked with people in New York occasionally. My coming down here led me to speak of it in some instances. Otherwise I should not have done so. But I have not found a man in this connection, recently, who was not in favor of its introduction.

Mr. WOOD. That is, in connection with your business?

Mr. DAVIDSON. No; I am speaking of men that I met in New York recently.

Mr. GAINES. You referred to a bridge builder?

Mr. DAVIDSON. Yes; and others

The CHAIRMAN. We are very much obliged to you, Mr. Davidson.

Mr. DAVIDSON. Mr. Chairman, a point has occurred to me, if I may speak again, briefly.

The CHAIRMAN. Yes; we will be glad to hear you.

Mr. DAVIDSON. My predecessor, who has spoken so well on the side of his own work and on the scientific side as well as on the practical side of engineering, has not touched, it seems to me, the point which is uppermost in my mind in coming before you. It is in behalf of the common people of the United States that I appear. This gentleman and I or people of our type and class can take care of ourselves. We can use the metric system if we choose and gain its advantages. As far as we are concerned, we can afford the economic loss of our present confused and complicated system of weights and measures, but the common people, the working people, the people of the streets can not have the benefit of the metric system until Congress shall lead the way toward its adoption. Look at the Italian child buying peanuts by the liquid quart. You may say it is an insignificant illustration, but it is representative.

Our present system of weights and measures is confused, complicated, and difficult for the foreigner (of whom we have so many hundreds of thousands) to understand. The children in the public schools are wasting time in learning the present system. If Congress would make it unnecessary it would save months of every child's school life for better things.

Not only in school, but in training for the actual work of life and

after our complicated and incongruous system wastes time and mental effort for every workman, every clerk, every man and woman who has anything to do with weights and measures. The adoption of the metric system will be a saving from start to finish of life for all of these.

Mr. GAINES. Before you leave that, will you tell me, now, how that child was hurt, or anybody else, if she paid 15 cents a quart for the peanuts, or 7½ cents a pint, or a dollar a bushel?

Mr. DAVIDSON. She bought 20 per cent less peanuts than she ought to get for the money. I used that as an illustration. Now, gentlemen, I said that we could take care of ourselves. I can introduce the metric system into my business; this gentleman can into his, and the next gentleman can into his. It is perfectly legal. We have the opportunity of doing it if we wish, but you gentlemen can by your action tend to make it possible for everyone to enjoy the advantages of the system. The adoption of this bill, Mr. Chairman, appeals to me as being a step, and a long step, in the direction of educating the public to the benefits that the system can give.

Mr. GAINES. Now, I want to get back to the peanut proposition.

Mr. DAVIDSON. I shall be very glad to answer your questions.

Mr. GAINES. I want to ask you a question. You say you represent the common people, and I want to help you. That is what I am doing right now, or have been doing, in this matter. You said that if peanuts were sold by the metric system, every child would get more?

Mr. DAVIDSON. Every child would get an honest quart.

Mr. GAINES. An honest quart?

Mr. DAVIDSON. Yes.

Mr. GAINES. Are our quarts dishonest?

Mr. DAVIDSON. Yes.

Mr. GAINES. In what respect?

Mr. DAVIDSON. In that we have two. We have a dry quart and a liquid quart, and one contains 20 per cent less than the other.

Mr. GAINES. If the child pays 15 cents for a dry quart——

Mr. DAVIDSON. And gets a liquid quart, she is "done" 20 per cent.

Mr. GAINES. Then that is a fraud. It is not the fault of the measure; it is the fault of the man who sells it.

Mr. DAVIDSON. Exactly; and the law permits it.

Mr. GAINES. Yes; but after all it is a question of integrity of the people that you are trying to get at.

The CHAIRMAN. Your idea is there, Mr. Davidson, that the introduction of a new system, aside from the other advantages that it possesses or presents, would do away with a good deal of confusion that already exists in our system?

Mr. DAVIDSON. Certainly; of buying by one measure and selling by another. I do not know that it would make our tons of coal any different from what they are now, but I think we would buy and sell by the same ton.

Mr. GAINES. You and I have both bought peanuts, and we see them bought; and you always see, as a rule, a little glass or tumbler full of peanuts sitting on the Italian's stand. You go up and ask him, "How much is that worth?" "A nickel," he will say, or "a dime," regardless of whether it is a quart or a half a gallon or any other

measure; and you give him a nickel or a dime, just as he charges you for it. Now, is anybody cheated in that?

Mr. DAVIDSON. That is not the way they are sold in my country. They are sold there at so much a pint.

Mr. GAINES. Oh, if you go up and say, "Mr. Jones, I want a pint of peanuts," he will measure you out a pint. That is dry measure, of course; it ought to be dry measure.

Mr. DAVIDSON. It is not always.

Mr. GAINES. Then it is a fraud, and he ought to be punished for it; but there is nothing wrong with the measure. If I call for a dry measure or a wet measure, I ought to be given what I call for.

Mr. DAVIDSON. It comes from our having two standards.

Mr. GAINES. And dishonest sellers?

Mr. DAVIDSON. Yes; and dishonest sellers.

(The committee thereupon adjourned until Thursday, February 15, 1906, at 11 o'clock a. m.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, February 15, 1906.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. We have with us to-day Mr. Miller, Doctor Bell, and Mr. Hayes, the Assistant Secretary of Agriculture. Mr. Miller is a member of the American Society of Mechanical Engineers and a member of the special committee appointed by that society to investigate and report upon the metric system, and also a member of what is known as the "council" of that society. Mr. Miller would prefer to make a statement first and then any question that any members of the committee want to ask he will be willing to attempt to answer.

STATEMENT OF MR. FRED MILLER.

Mr. MILLER. Mr. Chairman and gentlemen of the committee, as the chairman has referred to my membership in the American Society of Mechanical Engineers, it may be well, possibly, to refer to the action of that society to some extent.

Mr. GAINES. Tell us what your business is first.

Mr. MILLER. I am an engineer, editor of a technical journal which is devoted to machine construction, and a member of the society named.

In the first place, a paper was presented before that society strongly opposing the metric system; some discussion resulted, and there were replies made to the paper, among which replies was one by myself. Finally, a resolution was introduced before the society severely condemning the metric system and expressing, or undertaking to express, the society's strong opposition to any action looking toward the adoption of the system, and in this, one of the most largely attended meetings the society ever had and where the discussion had been quite complete on both sides, the society voted by a strong vote against this resolution, and it was tabled; and my impression is that in nearly

every case—every case that has come to my notice—where any technical society has considered the subject of the metric system and the English system together, and where both sides have been represented in the discussion, the action has been in favor of the metric system. That has been so in every case that has come to my notice.

Mr. SCROGGY. I suggest this: That the committee do not care particularly about what may have occurred in different societies and what different views have been expressed. What the committee wants to be enlightened upon is the merits of the metric system.

The CHAIRMAN. I think Mr. Miller will get to that.

Mr. SCROGGY. I do not see that it is material to go into the action of different societies, and so on.

Mr. MILLER. I do not believe I can state anything new as regards the merits of the metric system. This committee has probably heard a great deal about the merits of the system, and to state in detail all the merits of the metric system would be to go over all the arguments that have been presented by the acre.

Mr. GAINES. Can you briefly state what those merits are, from your standpoint?

Mr. MILLER. Yes; I can do that.

Mr. GAINES. I do not want to interrupt you, and I am not going to if I can possibly avoid it.

Mr. MILLER. I will pass on, then, to the subject of the expense that may be imposed by the adoption of the metric system. That is a practical thing with which I am somewhat familiar.

Mr. SCROGGY. I would like to hear you on that.

Mr. MILLER. It has been stated by a number of persons who have appeared before this committee that the expense that would result from the enactment of this bill, or a similar bill, would be very great, and that it would fall particularly on the manufacturers of machinery in this country, because they would have to change their tools and drawings and work them over into the metric system immediately. Now, I do not favor any legislation which would impose a heavy expense upon the machinery manufacturers of this country; I do not believe that such a bill ought to be passed, and if I thought this present bill would result in any such expense I could not favor it; but I simply do not believe that it can be done.

Mr. WOOD. You do not believe there would be any heavy, large expense, you mean?

Mr. MILLER. I do not; I believe that so far as the effect of this bill is concerned it would be only the creation of an additional incentive to the manufacturer of machinery, made more or less in conformity with the metric system——

Mr. WOOD. Of course, in so far as this bill is concerned, we look upon this as simply a start in that direction. If it were made compulsory throughout the country, do you think the expense would be very large—the expense that would entail upon the manufacturers?

Mr. MILLER. I am not sure that I understand what you mean by the word "compulsory." If our present systems of manufacturing to the English system were to be abolished, and we suppose that everything should be done after a certain day in the way of manufacturing machinery and so on—everything done by every machine in every shop to be done by the metric system—then it would be expensive and

impracticable. We have certain standards in manufacture in which interchangeability is of the utmost importance, and if any bill were passed requiring all those standards to be thrown away it would entail a tremendous expense. But I do not think such legislation could be enforced. I do not think anybody has any idea of passing such legislation, and I do not dream that such action will be taken. For instance, the interchangeability of the air-brake connections on passenger trains has been referred to. We know it is very important where cars change from one railroad to another railroad that the connections in the air-hose should be interchangeable, so that the air brakes of one car will work with the air brakes of another car when any two cars are coupled together.

Now, it has been said that to change these connections to the metric system would produce endless confusion and expense, not only on account of the cost of the tools with which those connections are made, but that it would cause endless confusion because these air-hose connections would not interchange. Now, in regard to that, it seems to me that no bill that could be passed could possibly change the shop methods by which those connections are produced. If the Government were buying any of these air-brake connections and chose to specify in its specifications for bids the dimensions of these connections in the metric system, then those dimensions could be specified in the metric system within the limits of accuracy demanded in that work just as readily as they can be specified in the English system; but when the manufacturers produced these connections in the shops they would do it with the same tools that they now use, and when they were finished they would interchange, as they now do, and in every respect they would be the same connections that are now being used. The only difference would be that the Government could say that it would require those things to be made in the metric system, and that would simply be stating the dimensions in the metric system, and the result would be practically the same thing.

Mr. GAINES. Before you leave that subject I want to ask you a question. This is proposed to be compulsory on the Government. That would compel the Federal Government to adopt this in its business and compel every man who deals with the Government in that business to also adopt it, would it not?

Mr. MILLER. So far as business with the Government is concerned, yes. But the point I am trying to make is that up to the point of the presentation of this article to the Federal Government, which is to receive it, the man would continue to do all his work in the English system, but the two things are interchangeable, so far as expressing the dimensions in a common piece of work is concerned. In other words, the dimensions of a piece can be expressed in either the English system or the metric system, and with the degree of precision that is necessary for the kind of work that is in hand. Doctor Stratton can express the equivalent dimensions between the two systems within a millionth of an inch, perhaps, and within a much finer limit of error than is necessary in ordinary manufacturing processes.

In a great many lines of manufacture to express a measurement within a sixty-fourth of an inch is sufficient, and in other lines it is necessary to express the measurement within one-thousandth of an inch. The metric micrometers are made to measure to 0.01 of a mil-

limeter, and the English micrometer, the finest instrument generally used for measuring in machine shops, is made to 0.001 of an inch. It happens that the relations are such that the 0.01 of a millimeter is about equal to 0.001 of an inch divided by two and a half.

For 99 per cent of the work done in manufacturing operations you will see, then, that the limit of error is sufficiently close. If you want to go finer you can, but ordinarily it is not necessary to do so.

Of course, gentlemen, you are the best judges as to the objects and effects of the bill, but it has been stated that if this bill is passed, and if then any department of the Government should ask for bids on a machine to be constructed to the metric system, that manufacturers would bid upon it and that they would add to the amount of their bids the cost of the new tools needed to make machines in accordance with the metric system throughout. I will grant for the present that new tools would be required in such case. I do not believe they would, but we will grant that for the sake of the argument.

Now, having added to their tenders the cost of those new tools, and the bids being received by the Government, one manufacturer would get the contract for that machine or lot of machines, and having bid at a price sufficient to cover the special tools and appliances he would be paid for those special tools and appliances, of course, when he received the money for the machine or machines, and then he would have the tools on hand; he would be the only manufacturer in that line, perhaps, that would be so equipped, and he would be equipped at the cost of the Government.

Mr. GAINES. If he was bidding on a Government contract the Government would pay him for his tools?

Mr. MILLER. Yes; on the supposition, as stated in our committee report, that the consumer pays all necessary costs of production. Of course, that is a universal economic law. Now, it has been said that it might go somewhat further and that when a new bid is asked for a new machine or lot of machines that this man who has been equipped with the tools and appliances at the expense of the Government on the first contract might then say, "I am the only manufacturer who is so equipped; none of these others have these tools, and consequently I can bid again as high as I did before." Well, if he should do that, then it might be that some other manufacturer, knowing that he was going to bid that high, would also bid that high or only a little lower and get the contract, and he also would then be equipped, if he got the contract, at the Government expense.

Now, the statement is made that that is as far as it could ever go; that these two manufacturers would be equipped with tools and appliances for making machinery to the metric system and that the other manufacturers would be shut out. In reviewing that statement I simply set forth the methods of cost accounting that are actually in use——

Mr. SCROGGY. Then it would require an expense on the part of the Government to furnish these tools to the second party?

Mr. MILLER. Yes; on the assumption with which we started; but I deny that that is the way it would go. I have simply given the argument as it has been presented by others and think I have fairly stated it.

Mr. WOOD. If that were the case it would be a matter of some consequence, would it not?

Mr. MILLER. It would be a matter of some consequence; yes. In fact, it would be impracticable, and I do not think it would be wise——

Mr. WOOD. And every time a new contractor got a contract the Government would have to furnish that new contractor with a new set of tools, and so on ad infinitum.

Mr. MILLER. No; not quite that. The argument I am presenting is that the Government might have to provide two contractors with tools—that is, pay for the tools and the appliances for the first two contractors; that is, when they first bid they would bid high enough on the first contract to cover the new tools and appliances they would need to manufacture in accordance with the metric system, and also on the second bid they would do the same thing, but after that that would not be the case, after two manufacturers were so equipped none of the others could come in.

Mr. GAINES. Suppose the others did come in and underbid. Then they would have to have tools at the expense of the Government.

The CHAIRMAN. Not if they underbid.

Mr. GAINES. If the old bidder, No. 1, and bidder No. 2, who formerly succeeded, failed to underbid the third time, and the third successful bidder was a new man, then he would have to be supplied with tools by the Government?

Mr. MILLER. No; because they would only get these bids by bidding lower than the other men—that is, their bids would have to be at something less than the amount necessary to bid in order to cover the cost of the tools.

Mr. HARDWICK. Would not the effect of that be to limit competition to those who are supplied with tools?

Mr. MILLER. Yes; it would. But I am presenting the argument which is made by others, not my own argument——

Mr. BOWERSOCK. All this is on the suggestion that new tools would be required, which you deny?

Mr. MILLER. Exactly. I do not think new tools would be required. I also deny that is the proper way of accounting for the cost.

Mr. GAINES. If you deny that, how is the Government to manage the metric system, unless it supplies itself with tools for the metric system, and the man who deals with the Government gets metric measures, and at the expense of the Government?

Mr. MILLER. The Government is now supplied with metric measuring instruments, I think, and many of the manufacturers are also. I speak of special fixtures, jigs for locating holes and things that are necessary to the systematic manufacture of machines in large lots, where they are reduced to a scientific system of manufacture.

Mr. WOOD. Why do you say that you think no special expense would be incurred in providing new tools under the metric system?

The CHAIRMAN. Because the new tools would not be necessary.

Mr. MILLER. Not as I understand the import of this bill; no, they would not be necessary. This is only supposing——

Mr. GAINES. Please read the bill and give us your understanding of it and then proceed, because you are proceeding upon the idea that you do not know what the bill is.

The CHAIRMAN. As the witness has expressed a desire to proceed without interruption, I think we had better let him finish his state-

ment, and then the members of the committee may have an opportunity to ask any questions they desire.

Mr. MILLER. I do not pretend to be an expert in the interpretation of bills or upon legal matters. I am only a mechanic, and I am acquainted with manufacturing processes. The members of the committee can decide better than I can as to the effect of the bill.

Now, as a matter of fact, cost accounting is not done in the way that that argument is supposiing it is done. What would take place in such a case is that there would be a proposal for bids on a machine or a lot of machines to be built to the metric system for the Government, and as a matter of fact no bidder would think of adding to the cost of the machine the full cost of the tools and appliances that would be required to make that machine to the metric system, supposing such tools would be required throughout and he had to have a full equipment of such things. No man acquainted with cost accounting would think of adding the cost complete to that bid; he would add a certain percentage of the cost. In computing the cost of the machine or lot of machines the labor and the material and a certain percentage of the value of the equipment of the shop used in the production of that machine would be added.

When you get an equipment of tools in the shop they are supposed to last for many years and to be capable of producing very many machines, and if you get an equipment of such tools and charge the entire cost of those tools to the first machine or lot of machines you make with it, you could not sell it; nobody would be able to buy it. You simply charge the first machine with a certain small percentage of the cost of the tools required to produce it, and then in succeeding machines and in succeeding lots of machines you charge the same percentage of the cost of the tools to the production of those machines. For instance, we will say that bids are asked for a large machine of some kind and there are two machinery manufacturers who are competing for the work. One of them is equipped already with a large planer capable of doing the required work—a machine that may cost, say, $20,000. We will suppose that the other manufacturer has no such planer at all.

Now, if they are both bidding on the same job, one will not bid cheaper than the other because he has a machine in his shop and the other has not, because the man who has not the machine, but wants to go into that class of work, will never think of adding the full cost of the planer, $20,000. He will add the percentage of the cost that is called for by the cost-accounting systems; he will say the work on this machine will occupy that planer for so many days, and the expense will be so much, and that will be added to the cost of the bid, not the full cost of the planer, and it will be the same way with the tools required to build machinery to the metric system. Those commercial tools are now largely an article of commerce; they are catalogued in our American manufacturers' catalogues. That has been done on account of the foreign trade in such tools, and when they were purchased to be used in the production of any of these metric machines that might be called for by the Government, a per- would be put on the shelves of the manufacturers and invoiced at their remaining value—say 90 per cent of the cost. The occasion for the use of those tools would presumably present itself again, and a cer-

for the use of those tools would presumably present itself, and a certain percentage of those tools would again be charged. That is the way cost accounting is done, not in the imaginary way first stated, and the man who made the argument knows about that and is as familiar with those things as I am; he knows it perfectly.

Mr. GAINES. Who is the man?

Mr. MILLER. Mr. Halsey.

Mr. GAINES. Is he a manufacturer?

Mr. MILLER. Yes.

Mr. BOWERSOCK. I am a manufacturer myself, and I know it. I make machines and sell them and never have thought of adding the cost of a planer or a drill or a lathe to the cost of the machine.

Mr. MILLER. You could not do it.

Mr. BOWERSOCK. I would never sell a machine——

Mr. MILLER. You could not do business on that plan, of course.

Mr. HARDWICK. Suppose you would adopt a system that would require you to throw away all the stuff you had?

Mr. MILLER. That would be somewhat different.

Mr. HARDWICK. You would have to charge something for the stuff you had thrown away?

Mr. BOWERSOCK. But that is the smallest element of expense in any manufacturing in which I am engaged.

Mr. WOOD. You would charge all the transaction would bear?

Mr. BOWERSOCK. I would under any system; yes; that is part of the business.

Mr. MILLER. So far as throwing away what you have is concerned, there is a point right there. This change could not be made at once. This bill, in my opinion, if you will excuse me for saying it, is not intended, does not and can not cause manufacturers to throw away all their tools, say, on one day and commence with a new system another day.

There will be a lapping over, a gradual change from one to the other, as manufacturers are now doing, particularly in England, where they have a good deal of foreign trade. For instance, the firm of Willans & Robinson, of Rugby, England, are making engines to both systems. They started to make their engines to the English system, then their continental trade developed, they designed new sizes of their engines to the metric system, and they now work under both systems in the same shops. They are still making engines to the English system and they use the same machine tools for engines ordered designed and built to the metric system.

When they design a new size of engine or a new style of engine they design it to the metric system, and all those tools have to be renewed occasionally. They do not come to a time when they say, "We will throw away this set," but they renew them as they become worn out. When it finally comes to a new design, a new style machine or something of that kind, then it will be a commercial question for the manager of that works to decide as to whether he will design it in the metric system or in the English system.

Mr. GAINES. What is the name of that firm?

Mr. MILLER. Willans & Robinson, Rugby, England. They are among the most prominent engine builders in the world, and probably the most thoroughly systematized.

The CHAIRMAN. When the Government or anybody else orders an engine, does it specify sizes or anything to indicate special measurements, or does it buy an engine or a machine to do certain work?

Mr. MILLER. As I understand it, there are several different methods pursued. If it were ordering an engine or a dredge or anything of that kind, it would specify that the machine was to do certain work—that the engine was to develop a certain horsepower at a certain pressure of steam per square inch. But they could specify a certain horsepower with a certain number of atmospheres pressure per square centimeter, and could get the same engine as before, only the engine builder in dealing with the Government would say that it developed so many horsepower per atmosphere per square centimeter.

The CHAIRMAN. Suppose the Government wanted machinery to develop certain power in the production of electricity in this building; what would it have to do with the metric system?

Mr. MILLER. I would state it wanted a generator to produce a certain current; it would be to the engine builder——

The CHAIRMAN. What loss would it occasion to the Government?

Mr. MILLER. None whatever that I can see.

Mr. STRATTON. I have just served on a commission to recommend to the House Committee in regard to the power house for this building and all the Government buildings on Capitol Hill. Every machine was specified to have a certain power in kilowatts, which is the metric system already; everything was expressed in metric units.

Mr. GAINES. You could have ordered it in the English way?

Mr. STRATTON. No.

Mr. GAINES. Was it put up and set in motion by the metric system?

Mr. STRATTON. Yes; the horsepower is disappearing and the combined plant is rated by kilowatts. That was a million-dollar transaction.

Mr. MILLER. Yes; that is a good illustration.

The CHAIRMAN. I want to ask one question there. In that transaction what is involved in the way of new tools on the part of manufacturers?

Mr. STRATTON. None whatever.

The CHAIRMAN. I would like to have you state instances where it would be likely that the Government would let a contract involving the construction of new tools on the part of the contractor?

Mr. MILLER. Well, I can not think of any, Mr. Southard; I have thought considerably on that point, too.

Mr. HARDWICK. Let me ask a question. Would not that be true generally in all cases except in the electric engineering department or electricity, because that is the only one of the branches that has the metric system generally?

Mr. MILLER. Yes; that is the only one.

The CHAIRMAN. Suppose you are going to order steam instead of electricity, will you tell me how the Government would be called upon, or anybody else would be called upon in such a case, to make an expenditure in the way of new tools in order to construct this machinery?

Mr. HARDWICK. But I understand the bulk of the tools, at least in

most of the lines of manufacturing enterprises, except the electric line, are still under the English system.

The CHAIRMAN. Yes; but that is not my question.

Mr. HARDWICK. I did not understand it.

The CHAIRMAN. My question is, Would there be any transaction which would involve a supply of new tools, supposing you are contracting for steam engines instead of electric engines?

Mr. HARDWICK. Are not those steam engines made by tools that are gauged and fixed on the English system?

The CHAIRMAN. Suppose they are, then answer my question.

Mr. GAINES. This bill answers your question. It says:

That from and after the 1st of July, 1908, all the Departments of the Government of the United States in the transaction of business requiring the use of weight and measurement shall employ and use the weights and measures of the metric system.

Now there is both weight and measurement. Certainly the measurement in putting up this machinery, and therefore who transacted business with the Government will be compelled to use the metric system and therefore metric tools.

Mr. MILLER. I do not see it.

Mr. BOWERSOCK. It would not touch a steam plant or anything of the character of a steam plant; you would order an engine of a certain boiler size and a certain horsepower.

Mr. GAINES. Is that measurement?

Mr. BOWERSOCK. Measurement of quantity of power required; it would not possibly touch a single item expressed in this bill.

Mr. HARDWICK. Why not? If in point of fact the tools are now gauged under the present system and you started out to change all your specifications and all your requirements to the metric system, why would not the tools have to be changed too?

Mr. BOWERSOCK. Because in the purchase of a steam plant, engines, boilers, pumps, etc., no reference to what you term metric measurement would be necessary.

Mr. HARDWICK. If that is true that is a complete answer.

Mr. MILLER. I have a still more complete answer, I think. Suppose the Government issues a specification for an engine to be used on a naval vessel. Now, as that is commonly done they specify dimensions of the engine throughout—what size the piston shall be, what size the piston rod shall be, and what shall be the diameter of the crank pins, and so on.

Mr. HARDWICK. Inches and feet.

Mr. MILLER. Yes; and they are expected to be conformed to within the reasonable limits required by the accuracy demanded in that work.

Mr. GAINES. I want to ask Mr. Bowersock—he seems to be a practical man; you are too, but I have known him for a good many years—what do you understand by the language of this bill, it is compulsory?

The CHAIRMAN. I think we had better proceed.

Mr. GAINES (reading):

Shall employ and use the weights and measures of the metric system.

Is not that compulsory?

The CHAIRMAN. That is something we can discuss among ourselves.

Mr. WOOD. I understand the electric business has already adapted itself to the metric system.

Mr. MILLER. Yes, sir; it has.

Mr. WOOD. That is not the case in many other businesses.

Mr. MILLER. No.

Mr. WOOD. And is that the reason why there would be no extra expense to the use of the metric system in erecting an electric-light plant?

Mr. MILLER. No, it is not the reason; it is simply a little more convenient, because they are already there, they understand it and they are accustomed to it and they have already done what little study or investigation would be required.

Mr. HARDWICK. The witness started to give us what would be a valuable illustration about a naval ship. Will you finish that, Mr. Miller?

The CHAIRMAN. The witness was interrupted.

Mr. MILLER. We will suppose that the Navy Department specifies an engine for a naval vessel—specifies the dimensions of the engine in detail—goes over the whole engine and specifies how big the parts shall be, and all that, and they do that in feet and inches as at the present time.

Now, then if this bill passes, as I understand it, those dimensions would all be required to be stated in the metric measurements, and those who should bid upon them would be required to put their tenders in metric measurements. They would say, "We will make a piston of so many millimeters in diameter; we will make a piston rod of such dimensions and a crank of such dimensions," and so on, all in millimeters. Now, when complete it will conform to the nominal dimensions required, but in the shop where that engine is built the workmen, the foremen, and the draftsmen may all still work in the English system; everything that is produced in those works may be built with the tools and the taps and the gauges, and so on, that they have been working with before.

Mr. HARDWICK. They will translate from one to the other?

Mr. MILLER. When they come to deal with the Government officials they will say, "It is so many millimeters," referring to the measurements, because there is an equivalent for so many millimeters in the English system, and, as a matter of fact, the workmen, as I have said, have worked in the English system.

Mr. WOOD. Would it not require any change at all in the machinery?

Mr. MILLER. Not at all. It could be done as a matter of convenience, but it would be done only when it was commercially advantageous for the manufacturer to do it.

Mr. HARDWICK. Can you tell me why so many manufacturers have testified that that would be required; that this change spoken of would be required?

Mr. MILLER. Because I think they have misconstrued the bill and the effect of any bill that can be enacted by Congress. I do not believe Congress can enact a bill which can go behind the walls of a man's shop and say that his workmen shall use any certain tools or any certain measurements, and your bill does not attempt to specify what the dimensions of a machine shall be, it only says that they

shall be stated in the metric system. It does not state that a piston of an engine shall be so many millimeters in diameter; it can be any number of millimeters the designer decides upon, and he can state that in inches to his own workmen; but when he comes to deal with the Government he can state it in millimeters.

Mr. WOOD. A prior bill was broader than this bill, was it not?

The CHAIRMAN. Slightly broader.

Mr. WOOD. And that did have for its object the making of the metric system the legal system in place of the English system?

The CHAIRMAN. No; we got the opinion of the Attorney-General upon that bill, and he told us that in his opinion there was no compulsory feature, the bill did not involve any compulsory feature at all.

Mr. MILLER. Except upon the Government?

The CHAIRMAN. Except upon the Government. Of course, so far as the Departments of the Government are concerned, I suppose if this bill should pass, they would be called upon to use the metric weights and measurements in accordance with the provisions of the bill.

Mr. MILLER. Bearing on this point of the actual dimensions of machinery, it might be interesting to cite the testimony of Mr. Vauclain, who is superintendent of the Baldwin Locomotive Works in Philadelphia. The Baldwin Locomotive Works is probably the largest single machinery manufacturing plant in this country.

Mr. Vauclain is a member of the Franklin Institute, and he was one of a committee appointed to investigate the metric system. He went in as an antimetric man and became converted to the system, and his testimony was in favor of the metric system. In stating the point we have been discussing, and of course there is nobody more familiar with manufacturing systems than Mr. Vauclain, he said that the men doing work in the shop, the men who are producing the actual component parts of a locomotive, work to gauges which are supplied to them from the department that makes these gauges; that the men do not know and need not know what those gauges are; that they may be nominally 4 inches, for instance, but that they are usually a little smaller or a little larger, depending on the character of the fit required. If it is a press fit that is desired, they will be a little larger, while if it is a running fit they will be a little smaller, but they call it a 4-inch gauge.

The man using that gauge need not know the precise size of it, he simply works to the gauge, and he cares not what the actual dimensions of it are. But the men in the tool room who make the gauge, of course, know its actual diameter; they have records of it and they must reproduce it when required by refined instruments. Now, Mr. Vauclain went on to say that it made no difference to those men so far as the cost of production is concerned whether this gauge were made and the record of its size kept in the tool room in metric measurements or in English measurements. The men worked to the gauges just the same, and they would not care which system it was.

Mr. HARDWICK. The men would work mechanically to the gauge?

Mr. MILLER. Yes; that is Mr. Vauclain's opinion as a manufacturer, although without having had, so far as I know, the experience in actually doing that; but I have a record of a number of manufacturers who have actually done that thing, and they say that there is

no difference; that the difference between producing machinery in the metric system and in the English system is not to be discovered. I will cite the case of Mr. Drake——

Mr. STRATTON. I think the members of the committee should understand that the Baldwin Locomotive Works are in the same position that the Government is in if this bill passes. The Baldwin Locomotive Works are continually building locomotives for foreign people. They build a great many engines from foreign drawings, and those drawings are made in the metric system. The specifications are in the metric system, and it makes not one penny of difference in the cost of producing those locomotives whether the drawings are in the metric system or in the English system. That is precisely an analogous condition to our own in case the Government should design a machine, and, as a matter of fact, the Government does very little designing of machinery.

Mr. SCROGGY. That change of tools?

Mr. STRATTON. Yes; I investigated that case, because it bore so closely upon this question.

The CHAIRMAN. Supposing the Government should design a machine.

Mr. MILLER. The Government itself?

The CHAIRMAN. Supposing some official of the Govermnent should design a machine that he wanted built and invite bids upon it. Unless it was some standard make of machine, new tools would have to be built to make the machine just as much in one system as in the other?

Mr. MILLER. Yes; that would depend somewhat upon the nature of the machine.

The CHAIRMAN. I am saying unles it was some standard make of a machine.

Mr. MILLER. If this were a machine that would be probably the only one that would be required, then very few special tools would be required anyway, because these tools that I say are so expensive, that constitute such a large share of the cost of the equipment of a manufacturer, are tools that are used only in making those machines which are made in large numbers.

The CHAIRMAN. Then I will put the question this way: As many new tools would be required to make a machine in one system as in the other, provided it was a new design of machine—different-sized shafts, for instance?

Mr. MILLER. Well, I would not say as many new ones, because that would depend a little upon circumstances—for instance, the holes required. The practice is in constructing a machine to make various holes for the bearings and so on to the nominal diameter and to vary the fit by the size of the interior piece that goes in. They vary that because it is more convenient to do so. Those holes are fixed by reamers, which are articles of commerce; you can buy them in the market made in the metric system or in the English system at about the same price; they are listed at the same price. Now, then, if a manufacturer bidding on this thing did not happen to have these tools, then you might say if he were going to build a new machine to the metric system he would have to have the metric system reamers; but the point I make there is that the proportion of the cost of those

tools chargeable to that job would be no greater than if he used the English tools, because you would charge a certain percentage of the cost of the tools; that is the recognized and only proper way in counting cost.

Mr. KNOWLAND. Those drills would have to be replaced frequently, too?

Mr. MILLER. Yes; they wear out, and they have to be replaced all the time, anyway.

Mr. KNOWLAND. For instance, how many different jobs could a reamer be used on?

Mr. MILLER. It depends on the character of the work and also the degree of accuracy you must maintain. A reamer used in hard metal and where the limit of accuracy is fine will ream, say, 150 holes, and then it is done; but if the limit of accuracy is larger you might ream a thousand; but they all have to be renewed.

Mr. GAINES. Mr. Stratton said in building a locomotive for a foreign country they would use the metric system if the contract called for a metric-measurement-made engine, and that this private concern could make that engine all right. That is not the Government; that private individual is not the Government. This bill covers the Government contracts—transactions with the Government of the United States. Now, then, it says that these transactions in weight or measurement must be in the metric system. So that everyone dealing with the Government of the United States under this compulsory law would be compelled to use the metric measurements, and as 99 per cent of the contracts of the United States are made with the people of the United States, the people of the United States who deal with the Government would all have to employ the metric system and use metric tools, and if they did not have them they would have to get them.

Mr. MILLER. In reply I can only say that a locomotive built by the Baldwin Locomotive Works to metric specifications or to conform to drawings in metric measurements would be built by the same machines and tools, but the measurements would be expressed in the metric system.

Mr. GAINES. Can you tell how many tools that would have to be changed in making a gun——

Mr. MILLER. Let me finish the locomotive illustration.

Mr. GAINES. All right.

Mr. MILLER. Suppose the Baldwin Locomotive Works gets a tender for a locomotive to be built in the metric system, and the weights and measurements are required to be given in the metric system. They will do that, but it may be the same engine they would build for the Pennsylvania Railroad, and they will use the same tools. They are doing that every day.

Mr. HARDWICK. If they could do that for a foreign country, why could they not do it for the Government?

Mr. MILLER. They could and they would do it for the Government the same way.

Mr. KNOWLAND. And then the other firm could do the same thing whether they have the metric tools or not—they could translate their measurements into the metric system?

Mr. MILLER. Certainly they could. I have maintained that the

metric system will make steps toward its final complete adoption only as those steps are made commercially advantageous to the manufacturers, and as I understand it, this bill is intended to make it commercially advantageous—that is, familiarize our people with the use of the metric system so that these imaginary difficulties will largely disappear as the result of familiarity with the system. But I do not think it can compel any manufacturer to change any of his tools or throw away any of the tools he now uses.

Mr. SCROGGY. I do not think that requires any argument.

Mr. MILLER. But the opposite of that is contended. There have been acres of argument to prove that the opposite is the case.

Mr. HARDWICK. The practical effect would be to do that, it is argued—to compel the manufacturers to abandon their present tools.

Mr. MILLER. Some years ago I was in the works of the M. C. Bullock Manufacturing Company, Chicago. They are large manufacturers of mining machinery. They undertook to make in this country this Willans & Robinson engine which is made at Rugby. It is a noted engine and a very meritorious one. They received the drawings of that engine figured in the metric system, and I visited their works at Chicago and talked with the superintendent of the works. He had received his mechanical education in the service of the Lake Shore Railroad, and the Bullock Company had a metric bench-measuring machine made by the Pratt & Whitney Company, of Hartford, Conn. I asked him if he had found any special difficulty or if the men found any special difficulty in the use of the metric system in the same shop with the English system, and he said no; that the work was produced without any confusion, without any extra expense, so far as he could see.

Mr. KNOWLAND. Without additional tools?

Mr. MILLER. Yes; because these dimensions for this engine were specified in the integral dimensions—that is, instead of being a fractional number of millimeters there would be an even number of millimeters, because they were designed——

Mr. HARDWICK. In that event was it necessary to have additional tools?

Mr. MILLER. Yes; it was; but not because the measurements were metric. In a case of this kind, suppose they had undertaken to make the Willans & Robinson engine to drawings made to the English system, they still would have had to buy and make a full equipment of tools, only they would have been integral English measurements instead of integral metric measurements.

Mr. SCROGGY. That answers the question of the chairman, whether in the case of a new machine it would not be necessary under either system to get new tools.

Mr. MILLER. Yes; it would; but if the dimensions were expressed in English measurements it would be necessary to get new tools also, but those tools would cost just as much.

Mr. HARDWICK. I understand you to say that when these American people undertook to make this Willans & Robinson English engine the only reason they used new metric tools in the manufacture was because they had to have new tools of one sort or another?

Mr. MILLER. Yes; when a manufacturer takes up the manufacture of new machines he provides himself with tools, and as the thing

stands now whether they are English or metric in their measurements the difference in cost is nothing that amounts to anything; in fact, he will not be able to discover any difference in cost from his books, and we have evidence on that. The catalogues will show you that the standard tools, reamers, and all those things are quoted at the same price whether they are in the metric system or in the English system. I believe that is the case.

Mr. STRATTON. Yes; that is certainly true.

The CHAIRMAN. They are making twist drills in the metric system now.

Mr. MILLER. Yes, sir.

The CHAIRMAN. We used to hear a good deal about not being able to get twist drills in the metric system.

Mr. MILLER. Yes; but now they say in catalogues, "Made to the metric system, same price." Francis E. Drake, who was one of the American commissioners in the machinery exhibit at the Paris Exposition, 1900, and whom perhaps some of you know, is a very efficient man; he is not an engineer, but he is a man accustomed to the commercial end of manufacturing operations. He was over there at the time of the exposition, and so impressed certain manufacturers in Europe that he was engaged in Berlin for several years after the close of the exposition in general charge of the management of the business end of a large manufacturing concern there.

He told me that they did a great deal of work for the English market, and that the specifications were such that they had to build to the English measurements, while their continental work was built in accordance with the metric system. He being an expert cost accountant, and in charge of the business end of the business, he said the difference in cost of those goods was never discoverable; that the finest tests they could put it to never showed any difference in cost, although they were made in the same shop with essentially the same tools and by the same workmen.

Mr. BOWERSOCK. You were in favor of this system when you first began to give it any attention, were you?

Mr. MILLER. I was noncommittal. I commenced to investigate several years ago——

Mr. BOWERSOCK. Have you known any of these experts, these men such as you have referred to, who were in favor of the metric system and then changed and went to the other system?

Mr. MILLER. I have not known of any; no, sir.

Mr. GAINES. Mr. Miller, you spoke about somebody at the beginning of your testimony, you spoke about some resolution in opposition to the metric system——

Mr. MILLER. They were not adopted.

Mr. GAINES. Who was the author of those resolutions?

Mr. MILLER. Charles T. Porter.

Mr. GAINES. Will you send me a copy of those resolutions?

Mr. MILLER. I am not sure that I can; but I will do it if I can.

The CHAIRMAN. I think I can give you a copy of them.

Mr. MILLER. You heard them?

The CHAIRMAN. Yes; I was at the meeting.

Mr. GAINES. Where was this meeting held?

Mr. MILLER. In New York.

Mr. GAINES. I would like to have the address of that gentleman.

The CHAIRMAN. They were not adopted.

Mr. MILLER. No; those resolutions were tabled.

Mr. GAINES. It was first started by France; this metric system originated in France, did it not?

Mr. MILLER. It was started by cooperation among the different nations, I understand; I am not very familiar with the ancient history of the movement.

Mr. GAINES. It is a very ancient system, it has been very slowly adopted. Now, how do you account for it being so slowly adopted in the United States; how is it that our people in this country have not taken it up?

Mr. MILLER. Conservatism and opposition to change—opposition to new things; I do not know what else I can attribute it to. I ran across a curious case the other day which is illustrative, perhaps, of the thing. There is a certain watch factory in New England which makes watches with the diameters of certain parts stated in the metric measurement and with the length of the same pieces stated in the English measurements. I thought that was curious, and so I investigated a little and I found that shop was organized by Ambrose Webster, of Waltham, Mass. He was a fine mechanic and a firm believer in the metric system, and so he equipped it in accordance with the metric system——

Mr. GAINES. One other question.

Mr. MILLER. I would like to finish this illustration.

The CHAIRMAN. I think the gentleman ought to be allowed to finish.

Mr. GAINES. Very well.

Mr. MILLER. I asked them to state why they did that curious thing. I wrote to the company (as a mechanic I was interested in it) and I also asked them if the mixture of those two systems of measurement did not increase the cost of the manufacture of that part, as was claimed. I got a reply from one of the men in the office (not from a mechanic, as I had hoped, but from one of the business men in the company) in which he did not tell me anything of the origin of the curious practice, but he did say that it did not produce any confusion and did not add to the expense of producing the parts. The parts are made by the men in the works to gauges, as we speak of in the case of locomotives; they make these little pieces and they try the gauge on them and if they fit that is all that is necessary, and the workmen don't know and don't care whether they are working in the metric system or in the English system.

Mr. GAINES. How is it that this country, although comparatively a youth in the countries of the world, has become the most mighty on God's earth under this ordinary English system that you want to displace, and how is it that the other countries have not progressed with the same rapid strides, and yet you want to compel us to adopt their customs?

Mr. MILLER. There are a great many other differences between our country and these other countries. I have traveled in foreign countries, and I have noticed that the railroads and hotels are different in many of these countries from our railroads and hotels, and you can cite a dozen things in which our country differs from those

countries, and I should think it would be just as reasonable to attribute our preeminence to our different railroad system or different hotel system or to our decimal coinage system, for instance. We have the decimal coinage system here in the United States, which I think is far superior to the system of England; our system is more readily understood. Now, we might say that our prosperity is due to our coinage system. Your argument would apply to any proposed reform or improvement whatever just as well.

Mr. GAINES. The point I make is that we have prospered with our present system of measurements.

Mr. MILLER. We have prospered in spite of a good many things.

Mr. GAINES. And this is one of the most prosperous periods of our country, and yet you want to wipe it out and compel us to adopt some other system.

Mr. KNOWLAND. Probably our prosperity is due to the fact that we have followed the other countries in the gold standard.

Mr. MILLER. I think there has been a good deal of spread-eagleism about our preeminence anyway, and, as a matter of fact, many of the other countries are doing well and making great progress; for instance, Switzerland is one of the best and most successful manufacturing countries in the world. They use the metric system. You might attribute their success to the use of the metric system.

Mr. GAINES. You might attribute it to the fact that they are a republic.

Mr. MILLER. It is a fine republic; they have some points of superiority in their government.

The CHAIRMAN. We have Mr. Bell with us and Mr. Hayes, both of whom I know you would like to hear on this subject, but the hour of 12 has pretty nearly arrived and there would not be time to hear either one of them to-day.

Mr. BELL. I am a Washingtonian and can come here at any time.

Mr. HARDWICK. Will these gentlemen who are from a distance be here again, or are they compelled to go out of town?

The CHAIRMAN. Mr. Miller is the only one from a distance.

Mr. HAYES. I would like to suggest an amendment, and it is to make clear one matter in this bill. Secretary Wilson feels that before the Department of Agriculture would support this bill it ought to be cleared up a little bit. The bill reads "That from and after the 1st of July, 1908, all of the Departments of the Government of the United States, in the transaction of business requiring the use of weight and measurement, shall employ and use the weights and measures of the metric system." Now, we would like to know just what those words, "in the transaction of business," mean. In other words, would it affect our bulletins that we publish and send out to the people of this country? We might as well go out of business if we tried to put our bulletins in the metric system.

The CHAIRMAN. What do you mean?

Mr. HAYES. If we had to express our crop reports in the metric system, people would not understand them; they would not know what we were talking about.

The CHAIRMAN. You would not call that a transaction, would you?

Mr. HAYES. I would not, but it is not quite clear that the courts would not to my mind.

But there is another object in what I have to suggest, and to my mind it strengthens the purpose of the bill to add to the wording as you have it here, so that the bill, with the proposed amendment, will read as follows:

That from and after the first of July, nineteen hundred and eight, all of the Departments of the Government of the United States in the transaction of business requiring the use of weight and measurement shall employ and use the weights and measures of the metric system, and in publishing bulletins, instructions, reports, and documents shall gradually, from year to year, introduce the language of the metric system, as by beginning with duplicate columns in tabular statements and duplicate metric expressions in a portion of the quantitative statements not in tables.

That has got to be an educational measure. This bill simply serves notice on the Government that the country is behind this movement, and this would a little better express the idea that it is an educational movement, and it would require the Department to do more than they would without this further expression.

(Thereupon, at 12 o'clock, the committee adjourned until to-morrow, Friday, February 16, 1906, at 11 o'clock a. m.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Friday, February 16, 1906.

The committee met at 11 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. We have Dr. Alexander Graham Bell here this morning. I think he needs no introduction. He is the inventor of the Bell telephone, and you all know him by reputation. Doctor Bell, you will proceed in your own way, sitting down or standing up, just as you please.

STATEMENT OF MR. ALEXANDER GRAHAM BELL.

Mr. BELL. Mr. Chairman and gentleman, with your permission I shall remain seated, as this will be less formal and my remarks will be more in the nature of a talk. I do not know that I can be of very much assistance to the committee in discussing the bill under consideration. You have had so many abler men before you, and you must have had the merits of the metric system discussed almost ad nauseam.

The CHAIRMAN. Some of the members of the committee, I will say, are comparatively new on the committee, and might like to hear some of the arguments in favor of the metric system, although probably most of them have heard it discussed.

Mr. BELL. This is one of the briefest bills I have ever seen—only seven lines—but it is pregnant with consequences to the people of the United States. It means very much more than appears upon its face. This is a mandatory bill requiring the use of the metric system in the Departments of the Government, but of course Congress would not pass a bill of this kind unless as a step toward the introduction of the metric system generally in the United States. So that this really means, if you pass it, that you have decided to abolish the chaotic

systems of weights and measures we now have and substitute the metric system not simply for the Government Departments, but for the whole of the United States. This bill is simply a logical step in the consummation of the greater plan, and I hope it will pass.

It is obvious that our present system of weights and measures is in a very chaotic condition.

It certainly is not right that a coal company should be able to pay their miners by a ton of 2,240 pounds and then sell their coal by another ton of only 2,000 pounds. But even the pound itself varies in weight according to circumstances. Some of our people employ a pound of 16 ounces, others a pound of 12 ounces; so that it is necessary in business transactions to have a definite understanding as to the kind of pound we employ—whether avoirdupois or Troy weight. The ounce varies, too. Our apothecaries use an ounce of 8 drams, whereas there are 16 drams in an ounce avoirdupois. Thus the avoirdupois pound consists of 16 ounces of 16 drams each, equivalent to 256 drams; whereas the pound used by our apothecaries contains only 12 ounces of 8 drams each, equivalent to 96 drams.

In a similar manner we have different kinds of bushels and gallons and other measures in common use by different sections of our people, and if there is anything that is clear it seems to be this: That we need uniformity in our system of weights and measures.

Of course it matters little what system may be employed by an individual so far as he himself is concerned, but the moment he has dealings with other individuals the necessity for uniformity and a common understanding arises. The right of the individual to choose his own methods of measurement must give way to the convenience of the community of which he forms a part; in a similar manner the right of sections of the community like apothecaries, silversmiths, etc., to have their own peculiar systems of measurement should give way to the right of the community as a whole to have uniformity and a system convenient to all.

Every State in the Union might with perfect propriety have a different system of weights and measures if there were no interstate transactions or mingling of people from different parts of the country, but the interests of the nation as a whole demand uniformity throughout the length and breadth of the land.

In achieving such a result the United States might very well establish a peculiar system of its own without reference to the usages of other countries, if we formed an isolated people, having no dealings with the rest of the world. But in making a change—and the necessity for a change is very obvious—it would be advisable to adopt a system that would not only be convenient for our own people, but would also be convenient for the other peoples of the world with whom we carry on trade and commerce.

No one doubts that the metric system is superior to the crude methods of measurement we employ. It is therefore useless to expect that foreign countries employing the metrical system will ever change to our methods of measurement; from which it follows that if international uniformity is to be secured it is we who must give way. We must either adopt the metrical system or some other system—not our own—which may have some chance of international adoption.

At the present time, however, the metrical system is the only system known that has the ghost of a chance of being adopted universally by the world. As a matter of fact it is now international in character, for practically all of the civilized nations of the world have adopted it, with the exception of the English-speaking peoples, who employ an admittedly inferior system.

The metrical system was legalized in the United States in 1866 and is already in use by a portion of our people, thus adding to the existing confusion.

Our scientific men especially employ it, almost universally, and merchants having dealings with foreign countries are obliged to use it to a greater or less extent. Our imports from non-English-speaking countries are largely expressed in metrical measures, and in exporting to these countries our merchants must adopt the metrical system or be placed at a disadvantage with competitors who already employ it, for people accustomed to the metrical system will not take the trouble of translating our measures into their own system in order to understand what they are buying if they can obtain the same goods elsewhere expressed in the measures with which they are already familiar. There can be no question that in competing with metrical countries for the trade of the countries already employing the system our commerce is seriously handicapped by the inconvenient and antiquated systems of weights and measures in use in the United States. This means that we are at a disadvantage everywhere in the world excepting in dealing with Great Britain and her colonies.

Few people have any adequate conception of the amount of unnecessary labor involved in the use of our present weights and measures. Scientific men and merchants may have the necessary skill with figures to enable them to use the metrical system, but how about the common people of the country? It is just here that the metrical system possesses special advantages, reducing to a minimum the amount of labor and skill required in the solution of the every-day problems of life involving the use of figures.

The people of Great Britain, having no practical experience by actual use of the advantages of a decimal system of measurement, may have difficulty in realizing the amount of unnecessary drudgery through which they are obliged to go in order to obtain a solution of the simplest arithmetical problems, and they therefore have some excuse for remaining in the rear of progress.

But the United States has no such excuse to offer for her hesitation in joining the majority of the civilized nations of the world in the adoption of the metrical system. We already have a decimal system of money, and our people are therefore prepared to appreciate the great saving of labor involved in pushing the decimal principle into all our methods of measurement. We would not, if we could, go back to the old pounds, shillings, and pence of our ancestors, for we can realize, through our everyday experience with dollars and cents, the drudgery we are saved in all financial calculations, and are therefore prepared to appreciate, by analogy, that corresponding benefits would arise from our adoption of a decimal system in our weights and measures.

Let us compare for a moment the arithmetical processes involved in calculating by the old method of pounds, shillings, and pence

with the simpler process involved when we deal with dollars and cents, and then apply the results to the metric system of weights and measures. Take any problen that may occur to your mind. Let us take, for example, the figures 1906, which express the present year.

Now, if we had 1906 pennies and wanted to find out how many pounds, shillings, and pence this amounted to, we must divide 1906 by 12 to find the number of shillings, and then divide the product by 20 to ascertain the number of pounds. But the moment you adopt a decimal system of money like our own this kind of drudgery becomes entirely unnecessary. No calculation whatever is required in order to reduce the figures from one denomination to another. We simply shift the decimal point. We know at once, without calculation, that 1906 cents amount to $19.06.

In a similar manner, in using the metric system, we know without calculation that 1906 centimeters amount to 19.06 meters, and that 1906 grams amount to 1.906 kilograms. No calculation is involved.

Now compare this simple process with the laborious processes involved in the use of the ordinary measures of length and weight. Take 1,906 inches; how many feet and yards? We must divide 1,906 by 12 to find out the number of feet, and then divide the product by 3 to ascertain the number of yards; or take 1,906 ounces; how many pounds?

The CHAIRMAN. What kind of ounces?

Mr. BELL. Yes; what kind of ounce, for we have more than one. And what kind of pound—avoirdupois weight, Troy weight, or apothecaries' weight? In one case we may have to divide 1,906 by 16, in another by 12, but the point I wish to make is this: That a calculation of some sort is involved in the mere process of translation from one denomination to another in the same kind of measure, while on the metrical system all this kind of labor is saved; we merely shift the decimal point.

The amount of labor saved in calculating square measure and cubical measure is still more remarkable. Try square measure first. Take the figures 1, 2, 3, 4, 5, 6; 123,456 square inches; how many square feet?

I will not try to work it out, but you must divide this number by 144 to get the number of square feet. You will probably require paper and pencil to perform the computation; but on the metrical plan the solution is so easy that any intelligent person can arrive at the result mentally without any calculation whatever.

One hundred and twenty-three thousand four hundred and fifty-six square centimeters is equivalent to 12.3456 square meters.

Even should we forget that there are 10,000 square centimeters in a square meter, a moment's thought will enable us to recover the knowledge. The merest tyro knows that a meter consists of 100 centimeters (the name "centimeter" itself meaning one-hundredth of a meter), so that a square meter is a surface measuring 100 centimeters one way by 100 centimeters the other; 100 times 100 is 10,000—the figure 1 followed by four ciphers—which means that we must shift the decimal point four places to the left to ascertain the number of square meters.

Now try cubical measure; take any problem that comes to the mind.

Suppose we have a rectangular tank or reservoir of a certain

length, width, and depth; how much water will it hold, and how much will the water weigh?

We begin, of course, by multiplying together the length, width, and depth, to ascertain the cubical contents. This kind of calculation must be performed whatever the system of measurement employed, and I shall simply say that the computation is much simpler on the metrical plan than on the other, because no nondecimal fractions are involved. If the length, breadth, and depth be expressed by an exact number of feet, the labor involved in this portion of the calculation will be the same in both cases; but as a general rule in such computations one or more of the dimensions will not be exact in feet, but may be 4 feet " and a half," or 3 feet " 4 inches," etc., and we find it advisable to reduce the whole to the lowest denomination used, say, cubic inches. In such a case the metrical system has greatly the advantage. But after the whole computation is over and we have ascertained the cubical contents in the lowest denominations employed, the problem is solved if the metrical system is used, whereas much labor is required on the present system to put the answer into final shape.

We shall take a specific case, and in order to show the ease with which the problem can be mentally solved on the metric system with the very largest figures we will take a sum involving nine figures, thus running into the millions. Having measured our tank or reservoir and performed our initial calculation, suppose we find that the tank contains 123,456,789 cubic inches of water. How many gallons have we there? And how much does the water weigh?

I will not attempt to work the result out to its final conclusion, even with the aid of paper and pencil, for I must confess that my memory does not hold the exact number of cubic inches contained in a gallon, and I have no means of recovering this knowledge excepting by reference to a printed table. Then, again, my memory does not retain a distinct impression of the relation of weight to volume of water on our present system. The problem, therefore, is absolutely insoluble to me at the present moment. I must consult some reference book for the information that would enable me to work it out.

But put the problem in metrical terms and it is solved as soon as you have ascertained the cubical contents in any of the metrical denominations you prefer. The translation of the result into other more convenient denominations of the metrical system requires no calculation, and is a mere question of putting the decimal point in the proper place.

For example, suppose we find that our tank holds 123,456,789 cubic centimeters of water. How many liters have we there, and how much does the water weigh? The answer is 123,456,789 liters, weighing 123,456,789 kilograms.

Now, supposing we forget for the moment that 1 liter of water contains 1,000 cubic centimeters and weighs 1 kilogram, it is not necessary for us to consult a work of reference. A moment's consideration of the elementary propositions of the metric system will enable us to recover the knowledge for ourselves by mere mental computation.

We can not forget that 1 cubic centimeter of water weighs 1 gram, for that fact lies at the root of the relation of weight to volume in the metrical system.

We can not forget the equally elementary proposition that a cube having a side of 10 centimeters has a volume of 1 liter, for this lies at the root of the relation of length to volume on the metrical system.

If we don't know these facts we do not know the metrical system at all.

A cube having a side of 10 centimeters has a volume of 1 liter—then how many cubic centimeters are there in a liter? Picture to yourself a cube of the required dimensions and mentally calculate the cubical contents. It is 10 centimeters long, 10 centimeters wide, and 10 centimeters deep. Multiply these dimensions together. Ten times 10 is 100, and 10 times 100 is 1,000. Here we recover the forgotten fact that a liter contains 1,000 cubic centimeters.

But 1 cubic centimeter of water weighs 1 gram, from which it follows that 1,000 cubic centimeters (1 liter) weighs 1,000 grams (1 kilogram).

One thousand is the figure 1 followed by three ciphers, and this fact directs us to shift the decimal point three places to the left in order to convert cubic centimeters of water into liters of volume or kilograms of weight.

Contrast the amount of labor involved in this simple process with that involved in ascertaining from the number of cubic inches of water the volume of water in gallons and its weight in pounds. Nothing, I think, can better illustrate the fact that the metric system is a labor-saving device of the greatest importance and value.

It is safe to say that after the metric system has been adopted by the United States and our people have become accustomed to its use we would no more dream of going back to the present systems of weights and measures than we would think of carrying on the processes of arithmetic through the medium of the old Roman letters in place of the Arabic numerals we now employ.

The laborious nature of the calculations involved in the use of our ordinary measures was forced upon my attention a number of years ago by the fact that I commenced to carry on in my laboratory a series of experiments with man-lifting kites, enormous structures which had to be made very light in proportion to their supporting surfaces in order to carry a man up into the air.

These kites cost several hundred dollars apiece to construct, and it was therefore found advisable, after repeated failures, to calculate beforehand what the weight of a proposed structure would be and then calculate from the total amount of silk employed and from the angle which the oblique surfaces made with the horizon the amount of effective surface upon which the wind would act—the projection of the oblique surfaces on a horizontal plane. From these figures the ratio of weight to supporting surface for the whole structure was ascertained and the fact determined whether the proposetd kite would fly in a moderate wind before actually commencing its construction.

Well, the calculations proved to be so laborious that I found it simpler to translate the proposed measurements into metrical terms and then work out the solution on the metrical plan.

The translation of the ordinary measurements into metrical terms and vice versa involved considerable labor on my part, and it seemed advisable, therefore, to introduce the metric system into the laboratory and have all measurements made directly in metrical terms. The

only question in my mind was whether ordinary workmen—carpenters and mechanics accustomed to the usual methods of measurement—could or would employ the metric system.

The result may be of interest to the committee, as bearing upon the question of the ability of the common people of America to handle a new system of this kind.

No difficulty whatever was experienced in the use of the system; and the total expense involved in the change amounted to a few dollars for the purchase of a set of metrical weights and measures.

The same balances formerly employed were equally efficient in weighing by the metrical system, and even the old weights were utilized as supplementary weights, with their value in grams distinctly marked upon them. No change was required in the machinery and tools employed—simply a change in the method of measuring the output.

For convenience of reference, a chart of the metrical system was hung up in the workshop, but no effort was made to have the men master the new names involved, excepting so far as they were introduced by actual use. The names of which the men were most afraid, like dekagram, hectogram, dekameter, and hectometer, were really not required at all in actual use. The only terms employed at first were meter, centimeter, and gram. But the necessities of the laboratory soon introduced millimeter, kilogram, and liter. In this connection it is rather interesting to note that the word "decimeter," although understood, remained among the unused terms, the men preferring the expression "10 centimeters," just as we usually prefer to call a dime "10 cents" rather than a dime. So, too, a cubic decimeter (or liter) was preferably called a "cube of 10 centimeters."

So long as I did not ask my men to translate from one system into the other all was plain sailing. They would have difficulty in translating from pounds and ounces into grams or kilograms; or from feet and inches into centimeters or meters. But in the actual measurement of length with a metric measure in hand and in actual weighing with metrical weights no difficulty whatever has been experienced.

The use of the metric system in my laboratory has greatly facilitated all calculations and the men like it.

The CHAIRMAN. May I ask a question?

Mr. BELL. Certainly.

The CHAIRMAN. It has been contended by one or two people, at least, who have set out, I may say, to oppose the introduction of this system that in France and Germany, where it has been used as long as anywhere, it is not really the system of weights and measures of those countries. You have been there?

Mr. BELL. I have been in France, and, so far as my observation has gone, it seems to be in universal use there. I understand that it is also employed in Germany. In fact, we are one of the last nations to take it up. I understand thta nearly all of the civilized nations of the world have already adopted the metric system, with the exception of Great Britain, the United States, and the British colonies.

The CHAIRMAN. Of course, we realize that an argument can be made about the confusion which exists in weights and measures in

this country in a great many different lines. For instance, in the United States Mint they have four standards of weights—apothecary's, avoirdupois, Troy, and the metric measures.

Mr. BELL. I do not think any system of weights and measures has any chance of becoming universal except the metric system, and its growth during the short time it has been in existence seems to indicate that it has such a chance.

It has always been a matter of wonder to me why the United States, when it changed from the old system of pounds, shillings, and pence to the present dollars and cents, did not at the same time go the whole way and adopt the metric system of weights and measures. The answer, however, is simple. The metric system had not then been invented, or, rather, had not anywhere come into use. Propositions foreshadowing its advent were under consideration, but the metric system, as we now know, did not appear until after the passage of our coinage act of 1792. It was only adopted by France about the beginning of the nineteenth century, and if I remember rightly—and if not, Mr. Stratton will correct me—the first standard kilogram and the first standard meter were not deposited until 1830.

Mr. STRATTON. It was just about the time that we made the change in coinage that they were considering this system. Congress directed John Quincy Adams, the Secretary of State, to make an investigation in regard to the matter, and he did so, and he made a report in which he called attention to the fact that the metric system was then being developed, and he advised us to watch it closely, and he said that it was, in his opinion, a thing we ought to adopt if it proved successful.

Mr. BELL. In 1790 Jefferson advised a decimal system of weights and measures, and suggested the length of a second pendulum as a unit.

The CHAIRMAN. Of course he could not recommend the metric system because it had not been invented.

Mr. BELL. No. It was not introduced until later. Some action was taken by France in 1795, and in 1798 it was considered by some international gathering, but it was not legalized in France until 1801, and many years elapsed before legal standards were prepared.

It will hardly be necessary or advisable for me to take up further time before the committee in going over the old arguments with which you are already familiar.

The CHAIRMAN. I think the committee would like to hear some of the argument that you have the time to give them.

Mr. BELL. There is just one other point to which I desire to call attention, which seems to me to lie at the root of any proposed change in our methods of measurement in the direction of simplicity and ease of application, and it is this:

We employ a decimal system of arithmetic, from which it follows that a decimal system of measurement will be more easy for us to handle than any system in which the units of measurement do not progress by tens.

Our whole system of arithmetic itself is decimal in character. In counting we employ 10 figures 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. We then repeat these in groups of 10, advancing from 10 to 20, 30, 40, etc., up to 99. We then advance by groups of 10 times 10, namely, 100, 200, 300,

etc., to 999. Then by groups of 10 times 100, namely, 1,000, 2,000, 3,000, etc.

From this peculiarity in our method of enumeration it follows that any system in which the units of measurement advance by tens is specially suited to our system of arithmetic. It enables us to change from one denomination to another in the system as desired without special calculation by simply changing the place of the decimal point. Now the metric system is a decimal system of this character. It has already found favor with the world at large, and I think America should adopt it and make it her own. It really is astonishing when you come to work out complicated problems involving cubical measure, specific gravity, and the relation of volume to weight how much labor of calculation is saved by the use of the metrical measures.

The CHAIRMAN. If you will point out what that relation is specifically, perhaps it would be interesting. The members of the committee may understand, but I would like to see it.

Mr. BELL. There is a simple relation between volume and weight—1 cubic centimeter of water weighs 1 gram. That fact remembered is the key to the whole subject.

Now, if you want to calculate the weight of any other substance, you have simply to express its volume in cubic centimeters and multiply that by the specific gravity of the substance.

Let us take an illustration. Suppose we have a piece of iron or steel having a certain length, breadth, and thickness.

Mr. STRATTON. Here is one [handing Mr. Bell a piece of steel].

Mr. BELL. Thank you. Here is a piece of steel 10 centimeters long, 1 centimeter wide, and one-tenth of a centimeter thick (1 millimeter). What is its weight?

Now, you first find out the cubical contents of this piece of steel by multiplying together the length, breadth, and thickness, expressed in centimeters, so as to have the answer in cubic centimeters. It is 10 centimeters long and 1 centimeter wide. Ten times 1 is 10. It has a surface of 10 square centimeters. It is one-tenth of a centimeter thick. One-tenth of 10 is 1. That is, its volume is 1 cubic centimeter.

Now, multiply this by the specific gravity of steel and this will give you its weight expressed in grams. The specific gravity of steel, if I remember rightly, is somewhere about 8—that is, a piece of steel weighs about eight times its own volume of water. Eight times 1 is 8. This piece of steel then weighs about 8 grams.

Now, this happens to be a very simple case, but the process would give you the weight in grams whatever the dimensions of your piece of steel might be. If its volume should be 1,000,000 cubic centimeters its weight would be 8,000,000 grams—that is, if I have correctly expressed the specific gravity by 8. If you wish to express this weight in kilograms simply shift the decimal point three places to the left. A weight of 8,000,000 grams is equivalent to 8,000 kilograms.

The CHAIRMAN. The unit of length is what?

Mr. BELL. One meter. A centimeter is one-hundredth part of that.

The CHAIRMAN. And that is equal to 1 liter, which filled with water is 1 kilogram, the unit of weight?

Mr. BELL. The gram is the unit of weight, and 1 cubic centimeter of water weighs 1 gram. The liter is the unit of volume. It is equivalent to a cubical space 10 centimeters long, 10 centimeters wide, and 10 centimeters deep. It therefore holds 1,000 cubic centimeters of space, and if filled with water, the water would weigh 1,000 grams, or 1 kilogram.

The fact that 1 liter of water weighs 1 kilogram is easily remembered; but if forgotten, the knowledge is readily recovered from the basal fact that 1 cubic centimeter of water weighs 1 gram (the unit of weight).

To an American the metric system appears at first sight to be much more difficult of acquirement than it really is, on account of the un-English appearance of the terminology. After you have once mastered the meaning of the prefixes employed the whole system of terminology appears to be beautifully simple and appropriate, the words expressing by their etymology the numerical relation to the units of the system.

Thus when we know that deka means 10, hecto 100, and kilo 1,000 we see at once that a dekameter means 10 meters, hectometer 100 meters, kilometer 1,000 meters. So with the multiples of gram. A dekagram means 10 grams, hectogram 100 grams, and kilogram 1,000 grams.

So also when we know that deci means one-tenth, centi one-hundredth, and milli one-thousandth we see at once that decimeter means one-tenth of a meter, centimeter one-hundredth of a meter, and millimeter one-thousandth of a meter. In a similar manner when we examine the subdivisions of gram we see that a decigram means one-tenth of a gram, centigram one-hundredth of a gram, milligram one-thousandth of a gram, etc.

The foreign words employed need be no bar to the use of the metric system, for they are really not necessary to the system at all—the English equivalents would do as well. It is convenient, however, for many reasons to have some means of expressing all these various denominations in specific words coined for the purpose, although the names are not all of equal importance. As a matter of fact many of them are seldom used and a few suffice for ordinary purposes. This greatly simplifies the nomenclature for English-speaking persons. You will appreciate the point by reference to our monetary system. Our system of coinage provides for eagles, dollars, dimes, cents, and mills, but as a matter of fact dollars and cents are sufficient for all ordinary purposes. We do not reckon money by eagles or dimes; and mills are hardly ever alluded to, excepting by Congressmen and statisticians.

So, on the metric system the terms "kilogram" and "gram" are generally sufficient to express weight; and the other terms provided, which Americans find some difficulty in remembering, are really of little importance because so seldom used.

The CHAIRMAN. A meter and centimeter?

Mr. BELL. Yes; the meter and centimeter are generally sufficient for ordinary purposes, although millimeter is also needed for fine measurements, and kilometer for long distances, comparable to our mile, though little more than half its length.

The CHAIRMAN. And a liter?

Mr. BELL. Yes; liter is necessary also in expressing volume, but the multiples and subdivisions of it are not much used. These give you what may be called the "basal points." It is not really necessary to use the other names, although advisable to possess them in case of need for special purposes.

The CHAIRMAN. Just as you would remember pounds and quarts and dollars and cents.

Mr. BELL. Exactly.

The CHAIRMAN. When you know the value of anything expressed in one denomination you know it in all by looking at it?

Mr. BELL. Yes; and you are relieved of the enormous and unnecessary labor of calculation involved in the use of our present measures in merely translating from one denomination of the system into another.

The CHAIRMAN. Now, for the purposes of actual measurement, something has been said about the inch being a more convenient unit than the centimeter.

Mr. BELL. I do not see any reason why an inch should be more convenient than a centimeter, excepting that we have become accustomed to it. Usage will familiarize us with the centimeter, and then our judgment will probably be just the other way. That is now my attitude of mind, at all events.

The CHAIRMAN. Some of those who oppose the introduction of the metric system say that so far as its actual use is concerned there is no difference between the two systems, and others say that the inch is the more convenient unit; that the meter is not a convenient unit. There have been suggestions that it ought to be 40 inches.

Mr. BELL. Is not the fact of the matter this—that anything you are accustomed to is convenient?

The CHAIRMAN. Yes; I think so.

Mr. BELL. The metric system is already in extensive use. It has stood the test of a hundred years, and has displaced the older systems in most of the countries of the Old World. The metrical units have proved to be very convenient there, and they will be equally convenient to us when we become accustomed to them and use them.

If we employed them we would have the same system that is in use in most of the foreign countries with which we trade. The trade and commerce of the United States would then be enormously facilitated by reason of the fact of our using the same weights and measures employed by the people with whom we deal.

We can not expect a Frenchman or an Italian to translate from pounds and ounces into kilograms and grams, etc., to go through all this drudgery of translation, simply for the purpose of understanding the value of what he buys from us. So, of course, if he can get the things he wants from a country that already uses his own system of weights and measures, he will do so in preference to buying from us, and American trade will suffer. In my opinion the trade and commerce of the United States will be very much promoted by our adoption of that system of weights and measures which alone has any chance of becoming universal—the metric system.

The trade of Great Britain is already suffering from the competition of metric-using countries, and if we also adopt the system it will not be long before she follows our example. Then the metric system will become in fact the international system of the world.

We are better prepared to make the change than the British, because we have already become accustomed to a decimal currency, and can therefore appreciate the benefits we derive from the application of the decimal principle to monetary affairs. I am hopeful, therefore, that our people may be made to see, by analogy, that we would derive similar benefits from the adoption of the decimal principle in our system of weights and measures.

The CHAIRMAN. A good deal has been said on this point: We have been told that if we adopt the metric system it will necessitate the use of new tools and new drawings, and thereby become a matter of great expense to our manufacturers.

Mr. BELL. That is a matter for very grave consideration, and I think that the difficulty has been unduly magnified. While, of course, some of our more enterprising manufacturers would employ new machinery and tools specially adapted for metrical work, it does not necessarily follow that the old machines and tools would not be used for the purpose. The fact is, when you come to think it over, that the change does not necessarily involve any change in tools or machinery at all, or at least to any great extent. It is a question of arithmetic, not of tools or machinery. You can measure the work or output of the present tools and machinery just as well by the metric system as in the ordinary way. You can express the dimensions and weights of all the parts of machines where required by the metric system, and though the measurements might not be exact to a fraction of a millimeter or a fraction of a gram they could be rated at their true metrical value or at a closely approximated value in exact measure. It is only where very fine and accurate measurements are required that special tools would be needed.

The CHAIRMAN. In making a brand new machine you very often have to have special tools in order to economically manufacture the machine?

Mr. BELL. Yes. Of course the change would lead to the production of tools and machinery specially made for the metric system, but whether these tools are specially made for this purpose or not, they can be measured by the metric system.

The CHAIRMAN. You mean by that this, do you not, Doctor—that eventually it would come to be that they would manufacture in even metric sizes as they now manufacture in even sizes of the English system?

Mr. BELL. Yes, sir.

The CHAIRMAN. But it would not be an impossibility or a very great inconvenience to manufacture by the sizes they already have?

Mr. BELL. No. I mean it would not be necessary to throw away the machinery and tools they now have, because generally you would have a sufficient approximation to some exact metrical measurement for practical purposes. We can approximate, say, to a sixty-fourth of an inch or a fraction of a millimeter, which would be near enough to precise figures ordinarily. The old tools and machinery need not be thrown away; they can be used during the transitional period at whatever may be their metrical value. A tool or machine has only a limited life. It may last, say, ten years, and then it must be replaced. After the adoption of the metrical system the new tools and machines would certainly be constructed to an exact metrical scale. The old machinery, however, so long as it lasts, would be measured

by the metrical system, and you would simply rate it at its nearest equivalent in the metric system.

Mr. SCROGGY. I would like to ask a question in that connection. This bill, you must observe, uses the language that in the transaction of business requiring the use of weight and measurement the Government shall employ and use the weights and measures of the metric system. That apparently is mandatory. Now, could you suggest to this committee some amendment to that language by which the present tools, the tools now in use for manufacturing machinery that is now being manufactured, could still continue to be used and at the same time adopt the metric system as contemplated by this bill?

Mr. BELL. I do not think, sir, that this requires any amendment. The bill is only mandatory concerning the system of arithmetic to be used (the metric system) and leaves the question of tools, etc., open. It relates simply and exclusively to a method of measurement—the weights and measures of the metric system shall be used, that is all. It does not prescribe the kind of tools or machinery, or limit it in any way.

Mr. SCROGGY. Do you think that the language would admit of the use of the present tools?

Mr. BELL. You mean in the Government Departments?

Mr. SCROGGY. Yes.

Mr. BELL. I have not hitherto given that point consideration, but I should think that it would. It simply refers to the measurement of them. Take the present tools and measure them in the metric system.

I thought you referred especially to outside firms undertaking business for the Government, and whether they would be required to have new tools and machinery made in undertaking Government work. I don't think they would under the language of the bill. I have no doubt that some enterprising manufacturer would have metrical tools and appliances made for use in Government work, though this does not seem to me to be required by the bill. The same remarks apply to the tools and appliances at present in use in the Government Departments themselves. I can see nothing in the bill to require their abandonment and replacement by tools specially constructed for metrical measurement. The present tools can be measured metrically, which is all that is required by the present bill, so far as I understand it. I do not therefore see why any amendment is required to permit the use of any kind of machinery that may be desired. The bill simply prescribes that in the transaction of business requiring the use of weight and measurement, the Departments of the Government shall use the weights and measures of the metric system. Under this language, I take it that you can use anything under the sun if you measure it by the metric system. You can use a pound weight, if you please, if you put it down at 454 grams.

The CHAIRMAN. It would require the use of metric weights and measures, for instance, in the Treasury Department in determining duties on our imports and things of that kind.

Mr. BELL. Oh, yes.

The CHAIRMAN. There would be no difficulty about that, I should think.

Mr. BELL. I don't think there would. Indeed, it might be possible that the labor of the Department might be lightened, in fact—for

I presume that goods imported from foreign countries employing the metric system are invoiced in the countries of their origin by the metric system, and the Treasury Department—or the importing merchants at all events—would thus be saved the labor of translating the measures. The work of translation of the Department would thus be limited practically to imports from Great Britain and her colonies.

The CHAIRMAN. Of course the equivalents of the metric system of weights and measures are enacted into law now.

Mr. BELL. I believe so. I understand that the use of the metric system is already permissible in the United States by law. It is now competent for anyone to use it legally who chooses. This bill takes the next step and makes its use mandatory upon the Government Departments; and, of course, if you take that step it means that you are going further with legislation in the future and make it mandatory for the whole country.

The CHAIRMAN. If it proves satisfactory there.

Mr. BELL. If it proves satisfactory there. I hope, Mr. Chairman, that the experiment may be made, and feel sure that Congress will find no reason to reconsider such decision. I trust, sir, that the bill will be recommended by your committee.

Mr. DRESSER. Has not there been some objection made on account of land measurements?

The CHAIRMAN. The bills formerly introduced here have always contained an exception, and that exception was the Government survey, but that work is so nearly completed, so nearly done now, that I am told the author of this bill thought it was not worth while to except that from its provisions.

Mr. DRESSER. I know there was some talk on it last winter and that was one of the objections that were made.

Mr. BELL. Of course there is necessary friction in making the change, but this difficulty only belongs to the transition period.

The CHAIRMAN. I suppose there are about three things that the ordinary man or woman—I mean the man who has not any special use for weights and measures, but uses them ordinarily in trade—would have to remember, and that is the liter, the meter, and the kilogram; the liter, one-tenth more than a quart; the meter, a tenth more than a yard, and the kilogram, a tenth more than 2 pounds, about?

Mr. BELL. Yes. That is a very simple way of memorizing the radical points.

The CHAIRMAN. Do you imagine there will be any serious annoyance so far as what we call the common people are concerned?

Mr. BELL. I do not anticipate it. We simply have to be bold enough to take the step. All the difficulties lie in the transition period. All the difficulties in the metric system are in translating from one system to the other, but the moment you use the metric system alone there is no difficulty. The workmen in my laboratory used the metrical weights and measures right off. I did not ask them to translate from one system to the other, for that would speedily have developed their limitations of education. I simply asked them to use the metric system and they did it without difficulty. They now use meters and centimeters and grams and kilograms as if to the manner born, and they are simply common carpenters and me-

chanics. I consider them as an average sample of the common people. I do not anticipate any difficulty in the use of the metric system by itself, and if the Government will lead the way, the change must and will come, and we will be brought into line with the progressive nations of the world, instead of lagging behind.

Mr. SCROGGY. Legislating for the future and not for the past generations?

Mr. BELL. Yes, sir.

Mr. SCROGGY. The old fellows are passing from the stage and the young fellows are coming to the front.

Mr. BELL. Well, our forefathers legislated pretty well for the future in the adoption of the Constitution; and later Congress did well in abolishing the old system of pounds, shillings, and pence, and adopting the decimal system for our money; and we will do well for the future of the country if we provide the metric system for the whole of the United States.

The CHAIRMAN. Are there any other questions? If not, we are very much obliged to you, Professor Bell.

Mr. BELL. I am glad to have had the opportunity of appearing before you.

(Adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, February 22, 1906.

The committee met at 11.15 a. m., Hon. J. H. Southard in the chair.

The CHAIRMAN. Mr. Willet N. Hayes, Assistant Secretary of Agriculture, appears before the committee to-day to talk on the Littauer bill, to give us his views with reference to this bill and the advisibility of its passage.

Mr. HAYES. Mr. Chairman, I wish to discuss this matter of the metric system as to the way it would affect agriculture, the farmers, and their interests. Agriculture is rapidly becoming much more of a science, much more of an engineering proposition, if you please. It is building up an immense scientific literature—much more comparable with the literature of the engineering sciences than heretofore, and there are branches of the work of agricultural education, of research, which are peculiarly scientific and similar to the work of an engineer.

The management of the farm itself is being reduced to more of a systematic, engineer-like, scientific basis. In the Western States, where I have been a teacher for fifteen or twenty years, we are learning to look upon the farm as an institution which we can reduce to a systematic business proposition, with farm management, rotation schemes, projected years forward, so that once carried out in a systematic way under much simplified systems of bookkeeping, we can look backward through a long series of years averaging and interpreting the results, and then better developing a projected plan that goes forward through succeeding years according to system. Already plans have been devised for hundreds of farm propositions on farms which in a quite definite way arrange the scheme of rotation and decide upon the crops that are to be gathered and fed to live stock and

crops that are to be harvested for sale. These plans can be simply and definitely stated in drawings and brief statements which clearly project the system in which the farmer will take more interest and get larger results. Definite farm plans worked out and elaborated are much more nearly comparable, comparing the problems of one farm with another, and comparing a specified project on one farm with the same kind of a project on another farm, than has been possible with the lack of system almost universally in vogue.

The systems of weights and measures now in use are awkward in developing these plans, and in making the needed comparisons. You can see, for instance, that where we have weights of grain in bushels, as we have them now, it is a little awkward to reduce to a comparable form a statement of the amount or the value of oats grown on an acre, as compared with the amount of wheat or the amount of corn. This is somewhat complicated by different States having different standards, as one having oats at 28, and another 30, and another 32, and so on. If all of the grain and roughage were measured by one standard of weight and not by measure at all, as would be the rule under the metric system, then all comparisons which enter into these business statements of the farm would be comparable. We would compare the average of so much weight of oats on an acre through a long series of years with the weight of the wheat grown and with the weight of the corn. We could get into our minds the relative values for feeding purposes or for sale of each of these crops, as also for each of the kinds of roughage like fodder corn, timothy hay, wild hay, clover hay, and cowpeas hay. If they were all expressed under one standard we could much more easily compare in our minds the values of these different products. The comparisons are somewhat complicated by the fact that we use them for sale in the one case and for feeding to one class of animals or to another class of animals, where their values may be somewhat different, and we also get from them when we feed them fertilizer values, and these differ also with the different crops. With the complicated system of weights and measures we now use these comparisons are not clearly seen, no matter how our bookkeeping is done. Neither can farm plans be so well projected forward so as to plan the crops some years ahead.

Another general feature I see in this matter is the advantage of uniformity of weights and measures in marketing the products of the farms in both domestic markets and foreign. Our farmers would be considerably disturbed in making the change; they would have to learn the new system; they would probably feel that it imposed an unnecessary burden for this generation to carry for the benefit of the next generation; but what little I have done in using the metric system makes me believe the change could be brought about much more easily in matters of selling grain and other farm products than would at first seem, and there would be many advantages. The market quotations would be much more definite; there would be no chance of anyone misunderstanding whether a bushel was to be of one size or another, all being expressed in language that everyone had agreed upon.

In our foreign relations it would be an advantage. Even with those nations which have not the metric system, I dare say, it would be easier to translate from the weights and measures they now use

to the metric system rather than to our mixed system, the standards of which are so irregular.

The CHAIRMAN. Do our measures differ from those of Great Britain?

Mr. HAYES. Not in many respects. I am not very familiar with the weights and measures of Great Britain.

Mr. HARDWICK. How much extra expense would that involve?

Mr. HAYES. In changing for the market people it would cost very little.

The CHAIRMAN. Mr. Hayes is speaking in reference to farming.

Mr. HARDWICK. I thought he was speaking in reference to printing these bulletins.

The CHAIRMAN. No; he has not come to that.

Mr. HAYES. So far as educating the farmers——

Mr. HARDWICK. Are you in favor of undertaking that?

Mr. HAYES. Yes; personally I am.

Mr. HARDWICK. Do you believe it is wise for us to try to change the system generally for the people of the United States?

Mr. HAYES. I believe so; yes.

Mr. HARDWICK. Do you think the farmers would be in favor of it?

Mr. HAYES. I doubt very much whether a majority would be in favor of it, but I think they would find it to their interest very soon. I do not know what a vote would express, but of course they do not understand it very well yet. It has been taught more or less in the country schools; the teachers in the country schools who have come from normal schools and colleges have been teaching the metric system and have tried to get their pupils interested in it, so there is a great deal known about it among the school boys and girls of the country. True they know it not so much in the way of using it, and one can not remember these matters of weights and measures until he actually uses them; but when once actually used they are remembered very readily. The school system of America is admirably organized for doing its part in the matter of giving instruction in the metric system, but most of learning its use can only be done by practice. I think the older people would take hold of it a little slowly, but the young people would take hold of it readily.

Some mention has been made as to the publications of the Agricultural Department as to whether we could introduce the metric system into the public literature of the Department. This is rather a serious matter, because for a good many years a great many statements would have to be made both ways.

Mr. HARDWICK. That brings me to my question. How much additional expense would that involve, have you any general idea?

Mr. HAYES. No; but it would be very small as compared to the larger question of whether changing to the metric system is a good thing on the whole. It would only make a small additional expense. I would not undertake to put in the figures. The bulletins of the Department of Agriculture would be the larger cost, because they are printed in larger numbers than the bulletins of any other Government Department.

Mr. HARDWICK. Could you give me a percentage as to how much it would increase the cost of printing those bulletins?

Mr. HAYES. I would have to give the roughest kind of a guess.

Mr. HARDWICK. I understand that, but what would that guess be?

Mr. HAYES. That would be below 1 per cent.

Mr. HARDWICK. And even with that statement you do not claim it is the result of a special investigation?

Mr. HAYES. No; it might be higher. As I look at it these changes would come gradually. At first all bulletins would express under the system used, and for translations they could be put in parentheses.

The CHAIRMAN. To some extent you have to use the metric system of weights and measure, anyway, do you not?

Mr. HAYES. Yes; but not in bulletins to farmers.

Mr. HARDWICK. Not in the ordinary bulletins?

Mr. HAYES. No; the metric system would be introduced merely incidentally at first, rather as a means of educating people to its use and to warn them that it is coming, so that they would learn its use.

Mr. BOWERSOCK. In the matter of farmers' bulletins, my experience is that if a proper number only were printed there would be a saving of ten times the cost necessary to express the figures contained in the bulletins in the metric system, as well as in the English system. Do not those farmers' bulletins go to California?

Mr. HAYES. Yes, sir.

Mr. BOWERSOCK. Of what use are they out there, since California is on the cental basis so far as grain is concerned? Would any man presume to say to the people of California that they should accept our mode of selling grain, with so many different measures in use as against those that they use, at so much per hundred pounds or cental? No man would subject himself to the ridicule that would follow such a proposition.

Mr. HAYES. But would not the metric system, so far as the selling of grains is concerned, come into use much more readily in California on account of the system they now use there?

Mr. BOWERSOCK. So far as grains are concerned, the metric system is already in use.

Mr. HAYES. The same principle is in use, but not the same standards.

Mr. BOWERSOCK. The principle in buying and selling.

Mr. HARDWICK. I do not understand you to contend, do you, that because we issue the bulletins to them in the common standard of weights and measures in use throughout the country that that forces anything on them?

Mr. HAYES. I happen to be in charge of the Bureau of Statistics for the Department of Agriculture, and we translate the figures that come from our agent in California; we translate them into the English system, because most of the country understands them. Then we do force upon the California people the terms of the old weights and measures.

The CHAIRMAN. Now, so far as the actual use of the weights and measures is concerned, do you think there would be any considerable difficulty in using them even at the beginning?

Mr. HAYES. No; the farm scales and farm measures now in use—I mean the instruments now used—would have to be gradually changed, at some cost.

Mr. ———. Could you change the scales so that you could use

them under the new system? That is, could you not use different weights on the same scales, have kilograms instead of pounds, or would you have to change the whole scale?

Mr. HAYES. I think you would have to change the scale beams. That would be a good question to ask the manufacturers.

The CHAIRMAN. That is what we are advised, that there would have to be a new marking of the scale beam, that is all.

Mr. KNOWLAND. What per cent of cost would that be?

The CHAIRMAN. That you will find discussed in Mr. Troemner's testimony in the Fifty-sixth Congress.

Mr. ———. It occurred to me it might not be necessary to do anything but have some new weights. Could you not weigh things on the same scales in either system?

Mr. HAYES. I think not. It would be mixing up the two systems.

The CHAIRMAN. Some scales are marked for both systems.

Mr. HAYES. In our foreign market relations I feel sure this would greatly increase the probabilities of other countries using this system, and when once it was in general operation it would be very useful in foreign market relations. There is a movement on foot to organize an international system of crop reporting. It was started at a meeting in Rome a year ago, at the suggestion of an American, who induced the King of Italy to call the meeting. If that is ever made a reality, having a uniform way of expressing weights and measures would be very useful, as in assembling at one point the different crop statistics of the different countries into a common figure for the total acreage of a given crop, not a total acreage in one crop or in one state, but in all countries——

Mr. HARDWICK. Would not translation be a very easy thing?

Mr. HAYES. Yes; it would be easy.

Mr. HARDWICK. You would have to translate them anyhow, so far as language is concerned?

Mr. HAYES. It is not the matter of telegraphing once, but it is the presentation through the reports and in periodicals so the facts would be easily understood by all concerned, and not simply by a few Government experts on the one hand and market experts, many of whom are speculators, on the other; it would be a common language, and these facts would no longer more quickly reach these experts, but the whole of the people. I find that in these market matters it is difficult to express the figures given out in the crop statistics in a language that will readily be interpreted by the common business man or the farmer, so as to get the true meaning. We give it out in percentages, for instance, and the farmers may misinterpret the percentages in the way they are made at present. Prices have dropped, for instance, on an average of 5 per cent for twenty years, and the percentages for a given crop for a given month are not interpreted in harmony with those averages, and they may be misleading; and if figures could be presented in actual bales of cotton or bushels of corn, or under the new system, it would be better understood by all the people and the statistics would be more useful. There will be some difficulties, and we might even have to change the standard of our bale of cotton in some way.

The CHAIRMAN. Have you had any actual experience in farming, Mr. Hayes?

Mr. HAYES. Yes; since I was 12 years old.

The CHAIRMAN. You were then a practical farmer?

Mr. HAYES. I helped run my mother's farm from the time I was 12 years of age for a dozen years, and after that I owned farms in Minnesota.

Mr. HARDWICK. Wheat farms?

Mr. HAYES. Wheat and live stock; and I had charge of a number of experiment farms in stations and substations, where I managed the farming.

The CHAIRMAN. Of course you know that this bill applies only to the Departments of the Government?

Mr. HAYES. Yes, sir.

The CHAIRMAN. And it provides that in their transactions after a certain date they shall use the metric weights and measures. Now, what, if any, objection do you see to the passage of this bill, so far as your Department is concerned?

Mr. HAYES. I see no serious objection to it, so far as conducting our business transactions is concerned. If it applied to our bulletins and records—required us to publish those in the metric system—I think that that would be objectionable. The Secretary has said that he would not wish to agree to do that.

The CHAIRMAN. If you were allowed to publish as you have suggested—to state the equivalents of the English measures in the metric system—what objection would there be then?

Mr. HAYES. I do not see any objection that the Department itself would have, as compared with these larger questions of whether in the end it is a profitable thing for the American people to do. The interests of a Department would be very insignificant and scarcely worth consideration.

The CHAIRMAN. So even with reference to your bulletins you think there would be no great difficulty to get over?

Mr. HAYES. No; but Secretary Wilson is quite insistent that the bill as written or interpreted should not require——

Mr. HARDWICK. I started to ask you that——

The CHAIRMAN. I wish you would let Mr. Hayes finish his answer first.

Mr. HARDWICK. I thought he did finish.

Mr. HAYES. I simply wanted to say that the Secretary is quite insistent that there would be no doubt about the interpretation of this bill as meaning simply business operations. As I look at this bill it is simply a forewarning to the American people that this system is coming, and the bill ought to be so framed——

Mr. HARDWICK. I want to ask this question. Is it the construction of the Secretary of Agriculture or the Department of Agriculture, or is it the contention or belief, that this bill does require you to put the bulletins in the metric system, or what is the contention or belief out there about it?

Mr. HAYES. There is a doubt in the mind of the Secretary about it.

Mr. HARDWICK. He is uncertain?

Mr. HAYES. Yes. He is a little afraid that the interpretation of the bill would be that we would be compelled to use it wherever we made any figures, and that could be very easily remedied by amending the bill.

The CHAIRMAN. Who would interpret the bill?

Mr. HAYES. The Department would interpret it unless enjoined in some way.

The CHAIRMAN. Who would enjoin you?

Mr. HAYES. I don't know. I suggested a wording when I was here the other day.

Mr. HARDWICK. Let me get my own idea about this thing clear. Would the Department construe this language in here, without the amendment that you speak of, to require the expression of the weights and measures in the bulletins in the metric system?

Mr. HAYES. I should not.

Mr. HARDWICK. What about the Secretary?

Mr. HAYES. I am sure he would not want to and would not unless he had to do so.

Mr. HARDWICK. You have not had any legal advice on that subject?

Mr. HAYES. No; not at all.

Mr. HARDWICK. I simply wanted to understand that one point.

Mr. LILLEY. What was the amendment you suggested?

Mr. HAYES. I have not the amendment with me.

The CHAIRMAN. It will be found in the last hearing.

Mr. BOWERSOCK. Have you made as full a statement as you desire as to your belief that judgment as to the final effect—the general effect when this comes into use, if it should come into use?

Mr. HAYES. I do not know that I made that very clear, but I am, on the whole, of the opinion that it is a good move to make. It looks forward to the time when the metric system shall be almost universally used, and I think that is greatly to be desired.

Mr. HARDWICK. You think a universal language would be greatly desired, also, do you not?

Mr. HAYES. Yes; but that is not nearly as easily brought about as this is. Our boys and girls now spend much more time learning this old system in school than would be required to learn the metric system; and much more time is required to learn how to use the old English system in practice, and, in fact, people never learn to use it as well in practice as they would learn to use the metric system, because it is continually confusing in the mind for a whole lifetime. There are just a few elementary things to learn in the metric system. There are lots of facts—details—to learn in the old system. I have been a teacher of country schools and have taught arithmetic, and I know the difficulties that boys have in working with the figures in the old system, and I know it more truly after teaching farm management, where I have had several hundred boys from the farm who were to return to the farm. These boys bring to the classes in the agricultural high school the plans of their fathers' farms the first year, just as the father was conducting his farm, a history of the farm the previous year; and then in the second year they return and bring a plan of the farm for the intervening year; and during that same year, the second year of their school, they take the home farm as a basis and make a new plan for managing the farm and project it forward ten years. I learned a great deal about the figuring there that a bright farmer does or should do in working out his plans and in recording his results.

I have also had charge of rather extensive experiments in getting at the cost of crops and products of the farm, where for four years

I have had three men—one in each corner of Minnesota—on a route where he visited eight men daily and kept track of every hour's work of man and every hour's work of horse. He kept all the financial accounts of the farm and kept all weights and measures and tested the quality of the milk of each cow. We installed there wagon scales and smaller measures and kept a very detailed account of those 24 farms, and, with the bright young men who were in charge, we built up a system of bookkeeping to use in this work and also for the use of those farmers to continue using in their business when we have finished. So I have had a good deal of experience on that side of this question figuring, and I feel certain that the metric system would be a great help in doing farm business, especially in clearing up the farmer's vision, so he could see clearly what result should be secured and so he could see clearly how he could lay out his plans for the future.

Mr. HARDWICK. Is that because you think the decimal system is preferable to any nondecimal system?

Mr. HAYES. That is one element.

Mr. HARDWICK. And any other element?

Mr. HAYES. Yes; our lack of uniform system of weights and measures; they are not comparable, as I said in the beginning. If you had a farm lined up in a systematic way and were keeping account of that systematically, you could see all crops and costs and values in the same terms and compare one with the other—either two systems under comparison on the same farm or two farms in comparison. Our agricultural colleges and schools are bound to give us a great number of bright farmers who are trained in system in farm management, and as the years go on these men are going to keep accounts, and as they meet together they will compare the methods and results as they get up in meetings, as they put them in the agricultural press, and as they meet individually. And a literature is growing of scientific agriculture, and definite comparisons will be made all along the line. The metric system would be better in a system of text-books on agriculture than the system of weights and measures we now have. I think our people hardly realize what is coming in the way of an accumulation of a body of thought in agriculture, nor in reduction to pedagogical form for school work and for the use of practical people.

The CHAIRMAN. Are you disturbed in your work by the fact that a large number of units of the same name have different values—for instance, bushels and pounds?

Mr. HAYES. That is true of the bushel especially.

The CHAIRMAN. And how about the quart?

Mr. HAYES. That gives producers some disturbance, especially in the selling of fruits and articles that are sold in small quantities; the small measure is too often used by the buyer, and the other fellow, not being especially familiar with weights and measures, allows the matter to pass.

Mr. HARDWICK. There are only two kinds of quarts—liquid and dry?

Mr. HAYES. No; there is another kind. It is the dishonest kind.

Mr. HARDWICK. There might be a dishonest meter, too?

Mr. HAYES. Yes.

Mr. HARDWICK. Or a dishonest kilogram?

Mr. HAYES. But there would be far less opportunity of fraud with

the liter, for instance, because it is based on the meter, and it would not be so easy to cheat in the matter of weight as it would with our own measures of weight, because the metric measures of weight are based on the measures of length and capacity, and the volumes would oftener be tested, because everyone would know the simple formulæ for testing. People do not really know what the volume of the quart, for instance, is, and very rarely test their volume.

The CHAIRMAN. Going to a new system would have a tendency to do away with a large number of units of the same name having different values?

Mr. HAYES. Undoubtedly, especially in the case of the bushel and the ton; for instance, the long ton and short ton are confusing sometimes.

Mr. HARDWICK. The short ton is in general use, is it not? Is the long ton used very much?

Mr. HAYES. The short ton is almost wholly in use in farming, so far as I know. But when it comes to coal the long ton is often used.

The CHAIRMAN. Are our gallons uniform?

Mr. HAYES. No; because a gallon is based on the quart.

The CHAIRMAN. Our gallon is not the same as the English gallon, is it?

Mr. HAYES. I really do not know what the English gallon is.

The CHAIRMAN. The English gallon is about 20 per cent larger than ours.

Is our yard the same as the imperial yard, do you know?

Mr. STRATTON. It is not exactly, but is sufficiently near for practical use.

The CHAIRMAN. Are there any further questions that anyone would like to ask?

If not, as the hour of adjournment has arrived, this will conclude this hearing.

(Thereupon, at 12 o'clock, the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, March 1, 1906.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. Mr. Stratton, you have been invited to appear before the committee to-day to talk on the metric-system bill. We would be glad to have you begin your remarks by explaining just what the system is, what the units of the metric system are, what the value of each of those units is, and the relation which the units of length, volume, and weight sustain to each other.

STATEMENT OF MR. S. W. STRATTON, DIRECTOR OF THE BUREAU OF STANDARDS.

Mr. STRATTON. Mr. Chairman, it seems to me that the question of this bill and the question of the metric system are two different things, and, as I understand it, you wish me to say something about the metric system itself first.

The CHAIRMAN. That is one question I would like to have you answer, but you may take your own course as to whether you will do that first or later.

Mr. STRATTON. A great deal has been said in regard to the difficulty with which the metric system could be learned. There is another feature of this discussion that has appealed to me very much from the beginning, namely, that there is a difference between the scientific and the practical side of this question. People have adopted the metric system in scientific work for precisely the same reasons that they will adopt it in the end for use in the business affairs of everyday life, namely, its simplicity, its decimal character, and its international use. The system itself is founded upon the meter, which was originally intended to be a certain part of the earth's quadrant. Later measurements disclosed the fact that the original meter was not quite the exact proportion of the earth's quadrant it was intended to be, which makes no difference at all so long as its true relation to the earth's quadrant is known. However, there are other things in nature that serve to fix any standard of length better than the measurement of the earth's quadrant. The wave length of light is one that has been used successfully.

Having established the meter as the unit of length it was divided decimally. One-tenth part of it (called a decimeter) cubed forms the unit of volume. It is called the liter; it contains a cubic decimeter; its capacity is between that of the liquid and the dry quarts. The weight of a cubic decimeter of distilled water is 1,000 grams, or 1 kilogram. These units are the only ones the public will have to learn. People in looking at the metric tables see the prefixes deci, centi, and so on. They are words which indicate the number of times the unit is divided by ten or multiplied by ten, but they are no more used in ordinary practice than dimes, eagles, and mills are used. To express a sum of money we do not say so many eagles, so many dollars, so many dimes, so many cents, and so many mills, and yet they are all in the table of our money. It is necessary to remember but one unit, the others are expressed decimally. So, in measuring weight in the metric system the fractions of a kilogram are usually expressed as grams, but may be expressed in decimals of the kilogram.

It must not be supposed for a moment that because it is the metric system decimal halves and quarters can not be used the same as in any other system, but beyond halves and quarters, as, for example, eighths and sixteenths and thirty-seconds, any system becomes cumbersome. Halves and quarters only are used in ordinary transactions; but the system itself is as well adapted to that use as any other. It is not advisable, however, to carry the binary subdivisions beyond halves and quarters. We might use eighths and sixteenths of dollars, but it would not be convenient. The meter, the gram, and the liter, all definitely related to each other, form the basis of the metric system. Now, as to its simplicity. The system is simple, because we have but one unit of length, and from that we derive the units of weight and volume. In our customary system, as you well know, we have a lot of different units of length, weight, and capacity. We have yards, feet, inches, rods, and miles. The foot is 12 inches, and is a third part of the yard; the mile is so many feet, etc. These units were all developed independently, and afterwards adjusted to their

present relations. But think of the confusion and the waste of time and energy that results in translating from one of those dimensions to another. In the metric system the astronomer who measures the distance to the stars or the surveyor who measures distances on the earth, the workman in the shop, the scientist in the laboratory, all use units decimally related to each other. The scientist divides the milometer into thousandths, and sometimes divides that again by a thousand, hence using a millionth part of a milometer as a convenient unit in certain work, and yet these refined measurements can be translated into the measure of distance to the heavenly bodies by simply shifting the decimal point, and that is all there is to it.

Now, it seems to me that it must be obvious to everyone that the system of weights and measures and the system of money must have the same base as our system of numbers. If our system of numbers was based upon 12, it would be advisable to use the same base in weights and measures in money; the three should correspond; custom shows that. We are drifting toward the decimal system. The question is often asked, Why not decimalize our own system? Suppose we should. Shall it be the inch? Shall it be the foot? Both have been decimalized, but that does not do away with the odd ratios 3, 12, 16½, etc. I do not think there is a man in this room, and I hardly think there is one even at the Bureau of Standards, where we are accustomed to dealing with those things, that could repeat the complete tables of our irrational customary system. It seems to me that the time has come to establish a decimal system. To decimalize our own would involve changes just as great, just as radical, and just as hard to make as to adopt the metric system, and we would still be using a different system from the rest of the world. The next point in favor of the metric system is its international character.

You can say what you please about the metric system not being international; so far as all scientific work is concerned, it has been international for fifty years, and its use for all purposes is growing rapidly. It would be difficult to estimate the value to science of the fact that one can take up a journal published in a foreign language and read it, so far as the formulæ are concerned, without a knowledge of the language. A specialist in any particular line can recognize the formulæ as soon as he sees them, and I am pleased to say that the beginners of to-day are beginning to demand that same thing. Within the last three days I have seen our own technical journals printing the formulæ in the metric system of engineering work that is done abroad in metric countries. This same valuable characteristic that we find in the weights and measures of science, that necessity for a system which is international in character, is met with in commerce and trade just as soon as we begin to do business with the world. Every country in the world has had to unify its weights and measures as soon as the different sections of that country began to do business with each other. We did it in this way:

The Congress directed the Secretary of the Treasury to provide the States and the custom-houses with copies of the weights and measures that he had selected. He had selected a standard of length for use in the coast and geodetic surveys; in the customs service it was necessary to adopt a standard of weight and capacity. Congress adopted directly a standard of weight for use in the coinage. We practically had to unify the weights and measures of the country.

France did the same thing; Great Britain, Germany, and all countries have done so. Just as soon as the localities which had their own weights and measures began to do business with each other, they had to adopt a uniform system of weights and measures.

Now, the time has come when the countries of the world are doing business with each other, and it is essential that we should have a system which is international in character. The other day I talked with the representative of a manufacturer of a certain line of steam fittings, one of the largest in the country. He said: "We have three stocks for many pieces—one for Great Britain, one for metric countries, and another for this country." I asked: "What is the difference; why do you make three kinds?" He replied: "They are all alike, except in the screw threads." I said: "When you send your fittings to France or Germany you don't find it necessary to change the tools in manufacturing except as to the attaching screw thread?" and he said, "No." Then I said: "Why should you have to do any more when you sell them to this country?" He replied: "We would not expect to." Manufacturers have been led to believe that the adoption of the metric system will require them to use it in constructing the parts of an article or machine. They can do so if they choose, but I don't see why a manufacturer would be compelled to—he would not be compelled to. He would not do it unless he found it to his advantage, except in the case of articles that are sold by length, weight, or capacity measurements. That is my understanding of the whole proposition.

The question of the international character of weights and measures, it seems to me, is a very important one. We have in the metric system the only decimal system that has been proposed, and it is the only system that is international in character.

Granted that an international decimal system is desirable, the question arises, Can we decimalize our own system; and if so, can we force it upon the rest of the world?

The points I wish to emphasize are as follows: The metric system is a simple and scientific one; it is just as practical and it is scientific. The man who makes the distinction between the scientific and the practical is making a distinction that does not exist. If there is anything that is practical it is scientific work. It would not stand for a moment if it were not practical. It is a great mistake to suppose that the needs of scientific work are any different from manufacturing or trade as far as weights and measures are concerned. It is decimal system, and we ought to have a decimal system to correspond with our system of numbers and money; and it is the only system that has any chance of becoming universally adopted. In countries where it has been adopted there is no desire to change; there will be traces of other systems in metric countries as long as other countries have different systems. To say that the metric system has not been a success in the so-called metric countries because of the persistence of other weights and measures in particular cases is, in my opinion, utter nonsense.

Now, as to the bill, it is not my understanding that if the Government adopts the metric system it will do no more than to buy and sell by the meter, the kilogram, or the liter, where it uses the corresponding units in the customary system.

It has for its object the improvement of the public service by the adoption of a rational system of weights and measures in the transaction of public business and to encourage the adoption of the same system by the public.

There will be confusion, inconvenience, and expense during the transition stage, but to an extent that has been grossly exaggerated, due mainly to a misunderstanding of the bill. However, the ultimate result will far more than compensate for any inconvenience or immediate expense involved. Of course the metric system should not to be adopted for Government use if it is not the best one for the public as well; but in considering the question as to which is the best system either for the Government or for the public, or the advisability of making a change, the immediate expense, inconvenience, or any one interest should not have undue weight. The question must be considered from a general standpoint and its future effects.

It is feared by some that the adoption of the metric system in Government work will involve a hardship and expense to manufacturers. This may be true in some cases, but not many. Machines are not bought by the pound, yard, or gallon, but by size or number. The Government never designs or has built to order a machine or other article when one can be found to answer the purpose. In the case of a special machine, a case which rarely arises, it is about as easy to build it in one system as the other. To build it in the metric system would require the addition of new measuring tools, if it is desired to avoid translation, and in some cases new drills and such tools, provided it is desired to work in even metric sizes; but it is a mistake to suppose that the large and expensive machine tools would have to be changed materially.

Admitting that a manufacturer might have to buy extra measuring tools, and that there would be additional expense in some cases—but it has been overestimated—it seems to me that the effort on the part of the Government to bear that expense is a fair and just one. The Government buys great quantities of materials. They would have to be weighed and measured in the new system. It might in some cases cause temporary confusion and a slight hardship, but in the end, it seems to me, the advantages would far outweigh the inconvenience of the transition stage. Take, for example, the customs service. More than 50 per cent of our imports are from metric countries. This morning I heard one of the appraisers make a statement to the chairman of this committee that they found at least 75 per cent—am I right, Mr. Chairman?

The CHAIRMAN. Yes; 75 per cent. He said he thought he underestimated it when he said 75 per cent.

Mr. STRATTON. In the customs and internal-revenue service I do not think the introduction of the metric system would be very difficult. In the case of taxable liquors they would be measured in the metric system, and the revenue would be assessed at so much per liter instead of so much a gallon; but the revenue would still be the amount per gallon as provided by law, and the public could retain the gallon if desired or use the metric system.

In gauging liquors to express the contents of a cask to the nearest liter is sufficient. So in nine out of ten cases all that array of fractions that people said would result during the transition stage would disappear. It would be as unnecessary as it would to carry out the

price of a piece of beefsteak to a mill. What is the use of it? The thing is practical. It would cause some inconvenience for the time being, nobody denies that, but the men who are doing the work. I have talked with a great many young men in different branches of the Government service, the young men who are actually at the desks doing the work of designing and computing, and they favor the adoption of the metric system in almost every case.

It might cost the Government something to try this experiment, but not a large amount. I think it is well worthy of a trial. If manufacturers, if scientists, if engineers, if people all over the country, and in foreign countries, find it advantageous to adopt the metric system, is it not worth while that we should try the experiment? It is not a compulsory measure, as far as the public is concerned. It does not compel the people to use it, except in business transactions with the Government. It may result in the passing of a law adopting the metric-system weights and measures in commerce and trade, but I do not believe the time will ever come in this country when a manufacturer can not use whatever system of weights and measures he desires for construction purposes. Take the conditions as they exist to-day. I do not see that a manufacturer would be prohibited from using Spanish veras in manufacturing a machine if he chooses. I don't believe anybody would object or prohibit him from doing that. If we can imagine a case where it would be desirable—would lessen his work——

The CHAIRMAN. Or suit his customer?

Mr. STRATTON. Yes; that is the way to put it—to suit his customers, to make machines in Spanish veras. I think he would be allowed to do it.

Mr. LILLEY. You say that the time will never come when the manufacturers can not adopt and use any system that they see fit. If this is so much better for them why don't they do it? Why ask us to pass some law to make them do it if they have that opportunity?

Mr. STRATTON. We are not asking that you pass any law to make them do it, but to introduce it into the Government service.

Mr. LILLEY. You are trying to get the Government to adopt a system, and you know if they do adopt a system people doing business with them will have to follow in the same line. Is there anything to prevent the Government doing that now?

Mr. GAINES. Nothing whatever.

Mr. LILLEY. If it is so advantageous to them, why should we be asked to compel those people to do something that they will not do of their own volition?

Mr. STRATTON. Do you refer to the Government or to the public?

Mr. LILLEY. I mean we will have to go down to the navy-yard, as I understand, and arrange an entire new system of measurement of the material things that go into the construction of the Government's work down there.

Mr. GAINES. Compelled to do it, because this proposed bill is compulsory.

Mr. LILLEY. The Government could do that down there?

Mr. STRATTON. Yes.

The CHAIRMAN. They use it now in some departments.

Mr. STRATTON. Yes; the Government uses the metric system in some cases, and ought to use it far more than is done at present.

Mr. LILLEY. You are doing this as a matter of philanthropy; you are not interested in it a bit?

Mr. STRATTON. I think the Government should avail itself of the many advantages of the metric system, and should set the public a good example.

Mr. LILLEY. You are coming here as a matter of good citizenship to tell us what we ought to do, to give us information and law. Now, do you not think it would be better to let those people down there and all around gradually work into it without any disarrangement of the business of the department? If you are a philanthropist and are not interested in it, do you not think you had better let them work into it gradually?

Mr. STRATTON. That, Mr. Lilley, is a question which depends on whether or not we believe this is a good thing to do. I believe it is and that the time has come to adopt a better system of weights and measures.

Mr. GAINES. Do you want to be the sole judge of whether it is a good thing or not?

Mr. STRATTON. No; I am only expressing my opinion.

Mr. GAINES. This act was passed in 1866 and there are the measurements of liters and milometers and kilograms and so on that we have here in lieu of pints and quarts and pounds and so on. There is the statute.

The CHAIRMAN. You are referring to the statute establishing equivalents?

Mr. GAINES. Yes, sir.

Mr. LILLEY. Let me put myself right with you. Perhaps some of these questions should come before the committee later on when we are summing up the case, but you are here, as you say, entirely disinterested, with no interest in the matter whatever. Therefore I have a right——

Mr. STRATTON. I will not say that I am not interested in the movement to adopt the metric system.

Mr. LILLEY. Are you interested financially?

Mr. STRATTON. Not in the slightest, if that is what you mean. I am interested in seeing the Government adopt and use something that is rational, something that will save them money in the end, and something that I believe they will do in the end. Why should the mint at Philadelphia buy all its gold and silver in Troy weight; why should it buy its supplies in avoirdupois weight, and why should it do its analyses in the metric system?

Mr. GAINES. Has any trouble come from that?

Mr. STRATTON. What would you think of using four or five different kinds of money in your own business?

Mr. GAINES. Has any loss occurred to the people on account of the mint having to use those different kinds of weights?

Mr. STRATTON. Yes; it could not be otherwise. I heard of one instance where material was advertised for sale, and there was a misunderstanding as to what pound was meant, but this is a small matter as compared with the loss of time and the inefficiency that must result in any business whatever from using three different kinds of weights; speaking frankly, it ought not to be permitted.

Mr. GAINES. Has the Director of the Mint or any of the officers

in authority reported any loss that has been occasioned on account of this situation which you describe?

Mr. STRATTON. Not that I know of. I think the authorities are in favor of unifying their weights and measures. I do not see how they could feel otherwise about it.

Mr. LILLEY. Why don't they find it out?

Mr. STRATTON. I think they have.

Mr. LILLEY. Then they have the opportunity to change—the law gives them the privilege—and why don't they make the change?

Mr. STRATTON. I think you have had a representative of the mint before your committee, have you not, Mr. Chairman?

The CHAIRMAN. I think we had the Director of the Mint; yes.

Mr. STRATTON. I would be pleased to answer any questions.

Mr. LILLEY. I did not mean to interrupt.

The CHAIRMAN. Mr. Fischer, one of the appraisers, is here, and I would like to ask him one or two questions. You are one of the appraisers?

Mr. FISCHER. General appraiser, yes, sir; for the United States.

The CHAIRMAN. Where is your office?

Mr. FISCHER. Our main office is in New York.

The CHAIRMAN. What I was going to ask you is this: What proportion, in your judgment, of the imports of this country come invoiced in the metric system?

Mr. FISCHER. Fully 75 per cent.

The CHAIRMAN. So you have to deal in that department of the Government somewhat with metric weights and measures?

Mr. FISCHER. Yes.

The CHAIRMAN. From what countries do you get these invoices in the metric weights and measures?

Mr. FISCHER. Merchandise that comes from France, Germany, Austria, Italy, Spain, and all South American countries is by the metric system. Merchandise from Russia is according to its own standards, and merchandise from Turkey is according to its standards. Merchandise from Russia is in the pood, equal to 36 pounds of our measure, and from Turkey by the oke—I think it is 32 pounds.

The CHAIRMAN. Do you know of any movement in either of those countries to adopt the metric system?

Mr. FISCHER. It is agitated in England——

The CHAIRMAN. I am speaking about Russia and Turkey.

Mr. FISCHER. I am not fully informed on that. Our chief difficulty is in this. Merchandise coming from the great commercial centers of the world, except England, is by the metric system. We have to deal with the market value of merchandise in order to ascertain that so that the duties may be ascertained according to the law; they are invoiced to us by the metric system; as, for instance, so many meters of silk or so many meters of any other woven fabric or so many kilograms in weight of steel, or whatever they may be. It is necessary for us to convert that into our own measure in order to be able to collect the duties back, and a meter is 39 and a fraction inches, and a kilometer is a thousand meters, and a thousand kilograms is equivalent to our gross ton, 2,200 pounds; but if we had a simple system like the metric system in vogue here, we would have but one reckoning to make.

The CHAIRMAN. What would there be in the way of saving?

Mr. FISCHER. There would be a saving, not only to us, but those who have to deal with the foreigners.

Mr. GAINES. Would you dismiss any of those officers and do without them if the metric system were adopted?

Mr. FISCHER. No; but the adoption of the metric system would prevent the breaking down of men and making cripples of them, which is taking place now.

Mr. GAINES. Do you mean it breaks down officers to have to translate the metric system into our system? If you think that, don't you think it will break down our people if we adopt the metric system, because, then they will have to do translating from one system into the other themselves.

Mr. FISCHER. No; you might say you are opposed to any innovation. Other countries have adopted the metric system and found it to their advantage, and, as a nation, we do not close our eyes to improvements.

Mr. GAINES. What per cent are our exports in excess of our imports?

Mr. FISCHER. I could not tell you definitely. I would prefer to take the record on that. It is an excess, however.

Mr. GAINES. Our exports are in our own measurements?

Mr. FISCHER. I have nothing to do with our exports, but I doubt that very much.

Mr. GAINES. Do you think our exports are measured into the metric system?

Mr. FISCHER. I can not answer that definitely, but I will wager——

Mr. GAINES. Don't wager anything, but sit down at your desk and write me your reply to that question.

Mr. FISCHER. I will venture this remark now: Whenever a foreigner wants goods in this country he will ask what the charge is per meter or per kilogram.

Mr. GAINES. And we send our goods to them measured in our measurements?

Mr. FISCHER. No; in the measure they are ordered in by the foreigner.

Mr. GAINES. When we send our exports into the old country do they object to their coming in our measurements?

Mr. FISCHER. I don't think we send them in our measurements; they order them in their own measurements. For instance, if they want steel or machinery made, we will say, 36 millimeters, they will not order it 2.15 of an inch; that is too mixed for them; but they will order it in millimeters, or whatever they want it in. We find cannon aboard our ships that are four and a fraction inches——

Mr. GAINES. Do you know how cotton is measured up?

Mr. FISCHER. By the bale.

Mr. GAINES. I am asking for information.

Mr. FISCHER. If it is raw cotton in the bale it is measured by the kilo.

Mr. GAINES. Do the farmers down South measure it in kilos?

Mr. FISCHER. I don't think they have anything to do with the export certificates; the brokers do that.

Mr. GAINES. It goes in the bales?

Mr. FISCHER. Yes.

Mr. GAINES. And they don't make any objection to taking our cotton in the bale?

Mr. FISCHER. And I don't think our farmers would object to selling it in the metric system, either. Recently the important question arose, the tariff making the duty so much a bushel, as to what was the weight of a bushel of corn.

Mr. GAINES. I used to be able to tell it when I grew corn.

Mr. BOWERSOCK. This question of Mr. Gaines could be answered in a word. I buy wheat by the bushel. I sell it by the cargo in Liverpool; I do not sell a bushel; I have to change it to quarters, and they buy it over there in quarters.

Mr. GAINES. Will you tell us why, when we have had a permissive act since 1866—and I think there was one act even before that—why it is the people of the United States have not adopted it and the Government itself has not adopted it?

Mr. FISCHER. Well, Congress does many things it thinks it ought to——

Mr. GAINES. A Republican Congress did that. Why did they do it?

Mr. FISCHER. It is like a good many statutes we have against crime that are not enforced. Referring to bushels, there are two sizes of a bushel in different parts of the country—a difference of 4 pounds, I think. When you order by the bushel, unless you know what the prevailing size of the bushel is in that part of the country, you do not know how much you are getting.

Mr. GAINES. When I used to shell corn to go to mill I shelled 4 pecks to the bushel, and I didn't have any trouble, and the miller didn't have any trouble either when he took out his toll.

Mr. LILLEY. To make myself clear, I will ask you this question—although it is not, perhaps, exactly a question. These departments that are doing this work, where it is sought to make them change the system by which they do it, are all composed of bright, intelligent men, that know enough to adopt the best system, and their experience teaches them that which is the best, does it not?

Mr. FISCHER. Yes.

Mr. LILLEY. I could see some force in this bill if it proposed to go out and teach the farmer something that he did not have an opportunity to know, but I can not see any force in your attempting to teach the brightest men here in this country how to run their business.

Mr. FISCHER. It would not teach them at all, for they know now; they could teach us.

Mr. LILLEY. Why do they not adopt it of their own accord and why do you ask us to force them to do that which they have an opportunity to do and which they decline to do?

Mr. FISCHER. It is a matter of education. I do not think that they require any forcing. I think that they will be pleased to do it voluntarily. I understand that this will lead to an introduction of the matter in the public schools——

Mr. GAINES. It is already in the public school; it was there even when I had a chance to go to school two or three months in the year. How long have you been out of Congress?

Mr. FISCHER. Seven years.

Mr. GAINES. When did you go into your present office?

Mr. FISCHER. Seven years ago. I was promoted immediately on going out of Congress.

Mr. GAINES. You are a lawyer?

Mr. FISCHER. Yes.

Mr. GAINES. Did you study the metric system at school?

Mr. FISCHER. No; but I have learned it since. I think it is the most elegant system known.

Mr. GAINES. Did you have to learn it when you went into your present position?

Mr. FISCHER. Yes.

Mr. GAINES. How long did you have to go to school, so to speak, to learn this metric system?

Mr. FISCHER. It didn't take me very long. When I went to school, just as you did, I had to learn about the rod, the rood, and the chain, and the link, and I venture to say that there isn't a man in Congress to-day who could name all the different measures and tables.

Mr. GAINES. How long did you have to study the metric system after you were inducted into this important office before you were a master of the metric system?

Mr. FISCHER. I am not a master of it yet, but within six months and less I could cipher out anything in the metric system. Our currency is in metric—dimes, dollars, 10 mills make 1 cent, and so on. Ten dimes one dollar—that is metric.

The CHAIRMAN. That is all there is to it?

Mr. FISCHER. Yes. Our measures and weights, however, are very much like the English currency as it is at present. It is an educational question purely.

Mr. GAINES. Could you tell us to what extent the Government will have to employ this system if this law were passed? It is compulsory, you understand, and all of our mail will be weighed in the metric system; then all of our things that we measure—all of our material for ships, all of our material for powder, all of our material for food, all our material for clothes and arms, and everything that the Government, which is over a billion dollars a year, or about that, would have to be done in the metric system, which would ram it, jam it, as it were, into the people all over the United States to at once adopt the metric system.

Mr. FISCHER. I have not read the bill, but I understand it is limited to Government action——

Mr. GAINES. But would it not compel the people to go to school to learn the metric system in order to deal with the Government, and the Government is practically dealing with everybody in the United States?

Mr. FISCHER. I understand that the American public is the most intelligent public in the world, and being the most intelligent I think we can do whatever may be necessary in a very short time. The countries of Europe have adopted the system, and upon adopting it they immediately fell into the ways of the system, and I think that we can be relied upon to do as well as France and Germany and Austria and the other countries that have adopted it.

Mr. GAINES. Being so intelligent, we have not adopted it.

Mr. FISCHER. But we do not shut our eyes to improvements.

Mr. GAINES. And after this statute was passed we did not adopt it.

Mr. FISCHER. But that existing statute is not compulsory, but this would be compulsory, as I understand it.

The CHAIRMAN. It simply applies to the Government. I take it personally you approve of this legislation?

Mr. FISCHER. Yes; I approve of it very heartily.

Mr. BOWERSOCK. A question has been asked twice by Mr. Lilley, which I would like to refer to. I presume none of us doubt that our decimal currency is a good thing. If the people of the country had been left to take up a decimal currency system how long would it have been before they adopted such a system? We would have been under the English system of pounds, shillings, and pence to-day, I doubt not, except for the action taken by the Government, forcing the decimal system upon the people.

Mr. GAINES. Jefferson suggested that and worked it out, but he did not suggest this.

Mr. BOWERSOCK. He would if it had been in existence.

Mr. GAINES. I understand that Napoleon condemned it and that Gladstone condemned it and that John Quincy Adams condemned it.

The CHAIRMAN. I do not understand those things to be true at all.

Mr. STRATTON. Referring to Jefferson, there is no man in the country that tried to arrive at the same thing more than Jefferson did. His idea was that the meter should be the length of the second pendulum; he tried to do the same thing. Jefferson was very keenly alive to that.

Mr. GAINES. Will you be kind enough to furnish me or the chairman what he said on that?

Mr. STRATTON. Yes, sir.

Mr. GAINES. I want to ask some questions.

The CHAIRMAN. I want to ask some questions myself.

Mr. SOUTHALL. You say you are not interested in the metric system. You mean you are not pecuniarily interested in it?

Mr. STRATTON. No; but I am interested for this reason: For the last twenty-five years I have been familiar with the metric system, have worked in it, working in one system just as readily as in the other. I have directed workmen in the use of the metric system. I have introduced it to these individuals time and again and have never had the slightest trouble in teaching it to anybody within a very short time. I have been in a position to compare the metric system with our own system, and I am not only confident it is all that has been claimed for it, but it is more than that, and that a change to the metric system will be a step in progress.

Mr. SOUTHALL. My question was in regard to your statement that you were not interested in it. You mean you are not pecuniarly interested?

Mr. STRATTON. Not financially interested. I do not see how anybody could be. I am daily brought in contact with matters pertaining to weights and measures, and I could not help seeing the advantages of the system.

Mr. GAINES. What is your official position?

Mr. STRATTON. Director of the Bureau of Standards.

Mr. GAINES. What is the function of that Bureau?

Mr. STRATTON. To compare standards with the standards of the Government, to test measuring instruments, to determine the properties of materials.

Mr. GAINES. You teach in your Bureau the metric system?

Mr. STRATTON. We do not have to teach it; there is not a man in it that can not use it, unless it be some of the laborers who have had no occasion to use it. The results of a test are given to the public in the system requested, metric or customary; we have nothing to do with that, but our own laboratory and shop work is done almost entirely in the metric system. I do not think there is a man in the Bureau who did not know the metric system before he was employed, except the laborers and some of the mechanics. In the latter case we give them a rule or scale and set them to work. No particular instruction is necessary. It takes just about as long for any person to learn the metric system as it does for a person of the same degree of intelligence to learn our money system upon coming from a foreign country, and it does not take any college training to do that.

Mr. GAINES. Now, I want to get at the facts about this thing. You have been at every meeting of this committee on this point?

Mr. STRATTON. Not at all. I am interested in getting at the facts in this case. I wish I could attend all of the meetings. I am surprised at some of the nonsense that has been given in opposition to the bill, due, as I believe, to misunderstanding.

Mr. GAINES. Every meeting that I have attended except one. If your Bureau is not a teacher of this, if it is not interested in its maintenance, and you are not interested in the continuation of that bureau and the broadening of it, how is it you have taken such a lively interest in this?

Mr. STRATTON. That, I think, comes from a definition of "interest." I do not understand exactly what Mr. Lilley meant by interest. If you mean interested in the subject of weights and measures, I say yes, very much so, and if the Bureau is not interested in the subject of weights and measures I can say it would be unworthy of its existence.

Mr. BOWERSOCK. Do you presume it would make any difference with you, so far as your salary and position were concerned, whether the metric system was adopted or not?

Mr. STRATTON. Not the slightest; that has nothing to do with it. My convictions in regard to the metric system were reached long before I came to the Bureau of Standards.

Mr. LILLEY. Mr. Fischer stated in answer to a question of Mr. Gaines that he thought he could or did acquire sufficient knowledge of the metric system to enable him to transact his business in that system in six months.

Mr. GAINES. And then he said he didn't know all about it.

Mr. LILLEY. Do you think it will take people who have no knowledge of this system whatever—ordinary citizens—a longer time than six months to learn the system if it took Mr. Fischer six months?

Mr. STRATTON. That depends upon what you mean by learning the system. Any individual uses but two or three weights and measures; the ordinary individual uses the pound, gallon, yard, and their subdivisions. If we had the metric system, he would use the kilogram, the liter, the meter, and their subdivisions, which would be decimal, and he would learn them in fifteen minutes. The individual who has to go beyond that in weights and measures is nearly always a specialist. For instance, a druggist would go further and learn more of the subdivisions of the metric system; but, as I have said, the knowledge of this system that would be required by the ordinary

individual could be acquired in a very short time. The notion that the metric system is hard to learn is only entertained by those who have not taken the trouble to look the subject up—a matter of a few minutes to one of average intelligence.

The CHAIRMAN. Let me ask you a question, Mr. Lilley. Do you not think that if we were put back again into denominate numbers that some of us would require a little time to refresh our recollection and make us experts to do the work of an appraiser.

Mr. LILLEY. I certainly do. I regarded Mr. Fischer as a man who ought to take this up as quickly as any person in the United States, and much quicker than myself or the average person, and if it took him six months to learn the system I wonder how long will it take the most of us.

The CHAIRMAN. I do not think Mr. Fischer said how much time he spent on it during the six months.

Mr. STRATTON. I will guarantee to teach it to you in half an hour.

Mr. GAINES. And I want to say, further, that it took him six months, and he didn't fully understand it, and yet he had it in actual operation in his office.

The CHAIRMAN. It occurs to me that it would not take a child 9 years old half an hour to learn the principles of the system. If he once knows the meter he could learn in no time that the tenth of a meter cubed is the liter and knowing that the liter filled with water and weighed is the kilogram. I say it would not take the ordinary child 9 years old twenty minutes to understand those things if pointed out to him, and that is practically all there is to the metric system, so far as ordinary simple transactions are concerned.

Mr. LILLEY. If you will permit me, I would like to explain why I asked that question. I believe I could learn the system in half a day, but it has gone into the record that it took Mr. Fischer six months to learn it, and I wanted this gentleman to make that right if he cared to. He has said he can teach it to me in half an hour, and I believe I can learn it in half a day, anyway.

STATEMENT OF MR. S. S. DALE, OF BOSTON.

Mr. DALE. Mr. Chairman, we have been investigating this thing for five years, and since I made my statement here two years ago we have continued our investigations, and on a somewhat new line, through the National Association of Manufacturers. We addressed letters to various consuls in countries where this Littauer bill, or, rather, where a law imposing the system on the government has been adopted. We found, by reference to the records, that fourteen different countries had adopted a bill identical with this. It began with Greece in 1834. These replies we have from consuls, and other investigations we have made lead to the conclusion—in fact, it shows the fact—that in every one of those countries the Littauer plan has been a dead failure, the people have refused to follow the example of the government, and instead of the people following the law it has resulted in the government violating its own laws. Now, take it in the case of Greece. The report of Consul MacGonly——

The CHAIRMAN. Then your fear is that this legislation will not be effective?

Mr. DALE. It is not a theory; it is a fact, because it has been a failure in other countries. We want you to apply the scientific method to this. You know that water will freeze under 32°; therefore when the thermometer drops below that, water is ice. We have tried it on other people; we have tried it fourteen times under far more favorable conditions than we would in this country.

The CHAIRMAN. You did not understand my question. I say your fear is that this would not be effective.

Mr. DALE. It is not a fear; it is knowledge; it is as much knowledge as my knowledge that ice will form when the thermometer drops below 32°. The people will not take it, because they have not taken it, and human nature is the same the world over. Now, take the case of Spain. Greece adopted it in 1834, as I say the report says, and a perfect chaos resulted so far as weights and measures were concerned, made worse because of the trickling in, if I may use that expression, of the metric units and causing this constant conversion, which one witness has testified has made cripples in our customhouses.

The next country that tried this experiment was Spain, in 1849. We got no consular report as to that, but we got a report from a chaplain of the United States Army who investigated the case while he was stationed in the Philippines. That system (the metric system) applied in Spain and the Philippines from 1849 up to the time we took the Philippines and was in force there. The same result was found, that the people have resisted it successfully and instead of adopting it the government has been forced to adopt in some cases the English weights and measures, by force of the predominance of the English trade there; but the people generally have continued with their old Spanish weights and measures. Those are the two leading instances of the failure of the metric system where the government has tried to force it on the people. The other twelve cases are South American Latin countries, in which the same result has followed. So we do not ask you to take my opinion or any other antimetric man's opinion, but we ask you to look at these experiments, to investigate for yourself; the facts are easily obtained by you, because Mr. Halsey and I have dug them out, with the influence and the aid of the National Association of Manufacturers, and we do not ask you to take our say-so; you could get the same thing by pursuing independent investigations.

The CHAIRMAN. If 75 per cent of our imports, as Mr. Fischer has said, come into the country invoiced in the metric system (of course I know nothing about that personally, but Mr. Fischer knows about it, and has made that statement) we are obliged to deal with the metric system in the government work anyway.

Mr. DALE. I don't believe that statement. Of course, I don't know about all the imports, but I know how it is in textile manufactures. Mr. Littauer is a glove manufacturer. There is not a glove manufactured and imported in the United States that is not imported by the old French inch. In that connection I can also say that the wage list adopted by the workers in the glove factories and the manufacturers of gloves in Millau, France, in 1892, was based on the French inch, the French line, a twelfth of an inch. So I say, I do not believe that statement about 75 per cent of our imports being invoiced in the metric system.

Here is another point. For four or five months the Department of Labor has had two men—Mr. Burrell and Mr. Crist—investigating the Chinese markets to get information in regard to goods sold there, and to send it here in order to help our manufacturers capture the markets there. The principal commodity that the Chinese buy is cotton goods. These agents of the Department of Commerce and Labor have made a full investigation and report; they have sent on probably 2,000 samples of cotton goods selected in Shanghai and Teintsin, and other places in China, as far north as Manchuria, and also way into the south, and I had 500 of them sent to our office to be analyzed, and I have been analyzing two a day. I have not found any one of those 500 samples but what is sold by the English yard and weighed by the English pound and the width expressed in the English inch. Yesterday I was in the Bureau of Manufactures of the Department of Commerce and Labor. As I say, they have 2,000 samples there of these different kinds of goods which the Chinese buy, and they kindly sent me 200 of them. Here is a ribbon made for the Chinese Government. Here is what they call the chop [exhibiting a ribbon to the committee]; here is a woman's face, and that is a very important thing; that always has to be there; and here are the Chinese characters. You see on here, "12 yards; made in France."

Mr. GAINES. That is printed on there?

Mr. DALE. Yes.

Mr. GAINES. Where did you get that?

Mr. DALE. At the Bureau of Manufactures, from Mr. Carson.

Mr. BOWERSOCK. That is printed in English?

Mr. DALE. It is in English; yes.

Mr. BOWERSOCK. Of what advantage would that be to the Chinese?

Mr. DALE. They go by this face.

Mr. BOWERSOCK. Do they know anything about anything except the yard over there?

Mr. DALE. No; not in textile work.

Mr. BOWERSOCK. The first goods sold there were English goods, and they were sold by the yard, and they have never known any other measurement but the yard?

Mr. DALE. Yes.

Mr. BOWERSOCK. The same as they never knew anything but the Mexican dollar?

Mr. DALE. Yes. Mr. Littauer says we ought to advocate this bill because it would bring us in harmony with the rest of the world. I want to show you that if we adopted the metric system it would bring us out of harmony with the rest of the world, at least in one large industry, and that is textile manufactures.

The CHAIRMAN. We have had a number of communications from textile men; for instance, from Mr. Whitman——

Mr. DALE. I don't care for Mr. Whitman's opinion, and I only have fifteen minutes allowed me to give my own.

Here is a blanket which is sold in China, made in Holland, and the English measurements are on here. This is 48 by 78. Mr. Whitman says: "I don't know what they use in China, but I think the adoption of the metric system would help our trade there." That is absurd, and it could not be shown to be more absurd than by these facts which I am giving you here, that they use the English system,

and you can not sell to those Chinamen by the meter, you can not sell this ribbon except with this woman's face on it [exhibiting ribbon to committee]. Here is a piece of white lawn made in England, collected in China by Mr. Crist, 12 yards, 42 inches, medium quality, 100 pieces per bale, used for mosquito curtains and such things. This is now in great demand. This is "price per yard." I got it from Mr. Carson. Let me tell you that you have the English yard implanted so firmly over there, so far as the measuring of textile goods is concerned, that you can never make them adopt anything else, you have that firmly planted in the minds of those people, and there are 400,000,000 of them.

Let me illustrate how they hang to symbols. A Massachusetts mill a short time ago had occasion to change its brand on that chop. They had a rooster stamped on there, and the goods sold by that rooster, and when they changed the brand the engraver got the rooster's tail a little lower down than it was on the old one, and when they sent their goods over there the Chinamen would not take them on account of that rooster's tail being a little different from what they were accustomed to. That illustrates how those people live by symbols. From that you can see the difficulty you would have in trying to explain about selling goods to them by the meter. You can never make them change. If there is any judgment and common sense exercised you will not try to change that system over there. As a matter of fact, you can never change the English weights and measures, England can not change them herself——

The CHAIRMAN. I would like to ask one question right there. I understand at least on two different occasions the colonial premiers of the British Empire have unanimously passed a resolution to adopt the decimal system of weights and measures; I understand that at Toronto last year, where there were 600 representatives of the chambers of commerce of the British Empire, they passed by all but a unanimous vote a resolution favoring a compulsory adoption of the metric system; I understand that select committees on two different occasions, committees appointed by Parliament, practically unanimously reported in favor of the compulsory adoption of the metric system of measures there, and I understand further that this matter was referred to their consuls and almost unanimously the consuls of the British Government reported in favor of a change in their system of weights and measures. How does this sentiment get root there?

Mr. DALE. First, I will tell you that something even more ridiculous has occurred. The New Jersey legislature passed unanimously, without referring to a committee, a resolution that their Representatives and Senators in Congress should vote for this Littauer bill. I don't want to say anything but what I know, and I think it was done because they did not investigate it. There have been no such consular reports in England since 1895; and when the bill got into the House of Commons that was passed by the House of Lords—jammed through—and the leader, the responsible man in the English Government, Mr. Balfour, turned it down; and he said that it was already permissive and the people could use it if they wanted to.

The CHAIRMAN. Is he not on record as saying that it is the only rational system in the world?

Mr. DALE. Yes; and so am I. I don't care anything about opinions—I would change them 50 times a minute—but until you refute these practical facts I have given I will never change my opinion about the Chinese market.

Mr. LILLEY. You think this is the best system there is?

Mr. DALE. I do not. I think of the two the English system is the better. The English weights and measures have been adopted by the process of natural selection, the foot corresponding with the foot of the human body.

The CHAIRMAN. You are in favor of the barley corn and the foot?

Mr. DALE. I am not in favor of the barley corn, but the barley corn was a very good way of verifying the inch when there was no better way.

Mr. GAINES. To what extent would the adoption of the metric system put machinists and manufacturers of machinery to extra expense?

Mr. DALE. I am not a machinist, although I worked as a mill worker until I became an editor. When I went to school I learned the metric system, and I believed in it, because the schoolmaster told me it was the best thing——

The CHAIRMAN. Do you believe a universal system of weights and measures is a thing to be desired?

Mr. DALE. Yes.

The CHAIRMAN. Do you believe it is possible to have one?

Mr. DALE. I don't know; I think it is one of those things you had better leave to laws that are superior to the laws of Congress.

The CHAIRMAN. Well, do you believe that it is possible to have a universal system of weights and measures?

Mr. DALE. That is something too remote; I do not believe it is in the range of practical affairs.

The CHAIRMAN. Do you believe it is worth while to try to unify our weights and measures?

Mr. DALE. Yes.

The CHAIRMAN. Along what line?

Mr. DALE. I would by all means drop the Littauer bill; I would by all means get into touch with the facts outside of the United States as well as inside; I would by all means get into fair consultation with Great Britain, because this Littauer bill, if adopted, would simply create diversity——

The CHAIRMAN. Do you believe there is any system in existence that is likely to become universal?

Mr. DALE. That is too remote; I don't know. It requires a man of Herbert Spencer's——

The CHAIRMAN. Is not this true: That wherever they have a decimal system of weights and measures—and I do not confuse the two, because there is no decimal system worth talking about except the metric system—do you believe there is a country in the world having the decimal system where they would listen for one moment to a a proposition to go back to any other system?

Mr. DALE. I do not know a country in the world where they use the decimal system. I was in Paris last year, and I took occasion to see whether the metric system was used, and I bought stuff by the pound, and goods by the yard, and I can say that it is not——

The CHAIRMAN. I have a letter from a druggist in Missouri, in

which he says out of about 14,000 prescriptions that came into his drug store he has 10,000 in the metric measurements.

Mr. DALE. And no one has any objection to his using metric measurements.

The CHAIRMAN. So, I say, you can get metric grams and kilograms here, and you can buy by the pound or the ounce in France; so that does not prove anything one way or the other. I am simply trying to get your idea as to that question. What is your answer?

Mr. DALE. My idea is this: That the development of weights and measures is something that requires far more study than anyone has given to it. I think that John Quincy Adams's and Herbert Spencer's opinions are the best——

The CHAIRMAN. They are on both sides—for it and against it. But I will ask you this: We did adopt a decimal system of money. Would you not have thought it was impossible?

Mr. DALE. No; there were two different things. This is a committee on coinage; also on weights and measures; but there would be no greater mistake you could make than to confuse the two. The one measures value. What is value? Simply the inclination of a lever of supply and demand for which computation and counting is the basis, and therefore for which the basis of our notation is best. Therefore the decimal system is the best for coinage. But in weights and measures it is entirely different. You are then weighing material things—something that has weight, length, thickness, volume—and for that reason the rule that applies to one does not apply to the other.

Mr. BOWERSOCK. Are you not aware that practically the same arguments were used against the adoption of the decimal system of money that you are using to-day against the adoption of the metric system?

Mr. DALE. No.

Mr. BOWERSOCK. The same arguments were used.

Mr. DALE. I only know in the one case the Government imposes a standard of money on the people, and, of course, the people can not do business without a standard that is legal; whereas, on the other hand, all human history has shown that the customs of the people have fixed the standard of the government, and in these 14 different countries I have mentioned it was seen that the people would overrule the standard sought to be fixed by the government.

Mr. BOWERSOCK. In the case of small money transactions in this country fifty years ago, and to some extent even in my boyhood, there was more business done outside of the decimal system of money than in it. The shilling was a measure of value often used.

The CHAIRMAN. I was reading your testimony given on a former occasion. You say that in your system of accounts, in the manufacture of textiles, there was no convenient unit in the metric system; that the meter was too large and the millimeter too small, and that the inch was the convenient unit to adopt in your system of counts.

Mr. DALE. Yes.

The CHAIRMAN. I think you stated that.

Mr. DALE. If I understand you, you have stated it correctly.

The CHAIRMAN. If the inch is convenient, why would not 25 millimeters be convenient?

Mr. DALE. It would, but you have lost your decimal.

The CHAIRMAN. Why could you not take 30 millimeters?

Mr. DALE. You would get into 3 then. We have a unit now, and they use that inch for counting the picks. The French can not use the centimeter with safety, and therefore they have clung to the old French inch, and you will find to-day that they still use the old French inch for counting picks. You can not use 4 inches, because it is too long for textile workers to count. The threads have 4 inches. Speaking of counts, you used that word wrong.

Here is something published for the benefit of German manufacturers, and on it it says the counts are English. There is not a mill outside of France on this earth but what their sizes of yards are gauged by the sizes of that German card [indicating]. We heard Dr. Stratton speak of the international standard for scientific work. They have got it; let them keep it; but don't let them take away what we have got.

The CHAIRMAN. If the compulsory legislation, as you say, in France does not prevent their using the English system there, why would a bill merely relating to the departments of the Government have a serious effect here?

Mr. DALE. It would not; but there are two ways of looking at this—one is the immediate scope of this bill as it applies to the Government; and the other is the confessed object, which is the ultimate adoption of the metric system by legislation, compulsory on the people.

The CHAIRMAN. Do you not believe that commerce, which extends everywhere, will dominate the situation and determine what shall be the universal system of weights and measures, if we are to have one?

Mr. DALE. I do not know about that. That is something I can not answer, because it involves too many philosophical and technical considerations, but here I have given you examples of commerce. Here is Germany, and here are so many pages from a German textile paper, the leading one in Germany, published January 31.

Mr. GAINES. What is the name of it?

Mr. DALE. The Leipziger Monatshrift fur Textil-Industrie. It is the leading monthly magazine for the textile industry. On the first page is a plan for cotton mills, the layout of machinery and the production of the goods, and there is not a reference to the metric system.

Mr. GAINES. I have a letter from the American Society of Mechanical Engineers, signed by the secretary, inclosing a copy of the resolutions of that order, protesting against the passage of any bill adopting the metric system; and also a letter from Mr. A. T. Anderson, secreary-treasurer of the National Supply and Machinery Dealers' Association, of Cleveland, Ohio, dated February 26, 1906, sending me a copy of resolutions protesting against the enactment of any legislation adopting the metric system.

The CHAIRMAN. They may be inserted in the record.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
New York, February 24, 1906.

Hon. JOHN W. GAINES,
House of Representatives,
Committee on Coinage, Weights, and Measures,
Washington, D. C.

DEAR SIR: A member of our society wrote me asking that certain facts of record should be presented to your committee. It seemed appropriate that

such letter should be addressed to the chairman of the committee, and I therefore sent the information to him.

It has occurred to me that possibly it might be serviceable that this same information should be in your possession also, and I therefore inclose you copy of my letter to Mr. Southard and also copies of the pamphlets which are referred to in that transmittal.

Very truly, F. R. HUTTON, *Secretary.*

FEBRUARY 20, 1906.

Hon. J. H. SOUTHARD,
Chairman House Committee Coinage, Weights and Measures,
Washington, D. C.

MY DEAR SIR: A member of this society has requested me, as its secretary, to send you the following information. From page 69, of volume 24, of our transactions I quote the preamble and resolution:

"Whereas the technical press in 1902 published statements implying that the American Society of Mechanical Engineers had taken action withdrawing its opposition to the adoption of the metric system as the standard of weights and measures for the United States; and

"Whereas there is no foundation in fact for such statements: Therefore,

"*Resolved*, That the society hereby records the fact that at no time has it taken any action reversing its original attitude of opposition to the adoption of the metric system or susceptible of such interpretation."

After debate the resolution was passed.

On page 854, of volume 24, of its transactions, paper 975, is recorded the form of letter ballot by which opinion on the metric system and H. R. bill 2054 was requested and recorded. I send you under another cover copy of paper 975, containing the full text of this action.

Five hundred and nine ballots were counted, of which 103, or 20 per cent, were in favor of the adoption of the metric system of weights and measures as the only legal standard in the United States. Against the adoption of the metric system of weights and measures as the only legal standard in the United States 363 votes were cast, or 80 per cent. The same proportion was recorded against the adoption of the H. R. bill 2054, and in favor of it, respectively—342 against and 95 in favor.

The vote in favor of legislation which would promote the adoption of the metric system was 33 per cent; of the votes cast and against legislation which would promote the adoption of the metric system, 66 per cent. For full detail I refer you to the paper 975.

I also send you for your information paper 972, being a report submitted to the society by a committee made, intentionally, of two opponents of the metric system and two men in favor of it. I am sure that Mr. F. A. Halsey's paper entitled "The Metric System" (society's paper, No. 971), must be well known to you, and I do not inclose it in the package.

Very truly, F. R. HUTTON, *Secretary.*

THE NATIONAL SUPPLY AND MACHINERY DEALERS' ASSOCIATION,
Cleveland, February 26, 1906.

Hon. JOHN W. GAINES, *Washington, D. C.*

DEAR SIR: At the first annual convention of the National Supply and Machinery Dealers' Association, held at Fortress Monroe, Va., February 14, 15, and 16, 1906, the following resolutions were adopted:

"Whereas we oppose the present agitation to make the use of the metric system compulsory, as it entails unnecessary expense and inconvenience upon manufacturers and dealers in machinery and supplies: Therefore, be it

"*Resolved*, That we, the National Supply and Machinery Dealers' Association, in annual convention assembled, and the manufacturers here represented, respectfully urge upon the Congress of the United States that the optional legislation now in effect concerning the use of the metric system is sufficient for all practical purposes.

"*Resolved*, That the secretary be directed to forward copies of this resolution to the proper committees of Congress and to the publishers of the New York Herald."

Very truly, yours, A. T. ANDERSON,
Secretary-Treasurer.

ADDITIONAL STATEMENT OF MR. S. W. STRATTON, DIRECTOR OF THE BUREAU OF STANDARDS.

Mr. STRATTON. I think I covered the ground I wanted to cover pretty well, unless there are some questions.

The CHAIRMAN. I would like to ask a question or two.

We have had testimony before the committee to the effect that the introduction of metric weights and measures, provided the system was to come into general use, would cause expense and annoyance to the manufacturers because it would necessitate a change of drawings, plans, and also a change of tools. Now, I understand you have had some experience in mechanics and some experience in manufacturing. What do you say about that?

Mr. STRATTON. The answer to the question would be different for each kind of manufacture. There is no question but what there would be some confusion and some expense for a time. The expense in some branches would be more than in others. I think the question of expense has been very greatly exaggerated, due to a misunderstanding of what would be required or what manufacturers would have to do in case the metric system was adopted. In those countries where the metric system have been adopted the laws which have been enacted have referred to commerce and trade, and I think that is what we have in mind when we speak of the adoption of the metric system here. The introduction into manufacturing has been gradual and has been left very largely to the interests involved. The fact that the textile industries in metric countries still use in part other weights and measures is not because they are any better suited for that industry, but because they buy their materials from countries which use the English system and that they have been allowed to retain the old units wherever desired. After all, the only place the public comes in contact with these manufacturers is in the buying and selling of cloth; a change from the yard to the meter would be required in business transactions involving the measurement of cloth. Any other change in the weights and measures used in the textile industries should, in my opinion, be left to the interests involved.

I think the fact our machine tool builders and our manufacturers generally meet very quickly the conditions necessary to establish a trade in Germany or France (metric countries) is proof that they can meet those same conditions. There are very few manufacturers that have ever turned down an order from abroad because the order has come in the metric system. Our manufacturers are just as bright and just as progressive as those of any other country; the machine which is sold to a foreign country must turn out its output in the metric system, and that is all that would be required, even in this country.

It is absurd to say, and I say this most emphatically, that the metric system has not been a success in those countries in which it has been adopted. I have been in those countries five different times, have looked into this matter pretty thoroughly, and have come in contact with a great many industries there. I find that occasionally in shipbuilding, especially in places where they manufacture for the English trade and in some other cases they use the English system of

screw threads to a certain extent. But they would rather not do it. Even in these extreme cases they use the Whitmoth screw threads, and not the United States standard. This is another fact showing that these compulsory laws (so called, and they are) do not cover such cases. The German manufacturers have been left to use whatever screw threads they find necessary to meet the conditions of trade. They are to-day using the English screw threads, whenever they come in contact with certain classes of work; but the general tendency throughout the German Empire is toward metric screw threads whenever a new machine is designed or a new industry started. Each country will settle such questions for itself; the change in technical standards will be a gradual one to the international system when it is practicable and economical.

The only thing that would be required by this bill is that the output or product which is now sold by the pound, yard, or gallon would be handled in kilograms, meters, and liters. The gentleman who testified here this morning (Mr. Adamson) says that he puts up "chemicals in pounds or kilos as the order comes in; it is as easy to do it one way as it is the other."

We not only have confusion in our own weights and measures, but we have several different units of the same name. I think there are half a dozen different things meant by the term ton. To my mind the effect of this measure would be the gradual retirement of one system and the introduction of the other. We shall have to do it some day; it is certainly coming; it is only a question of how we can do it with the least confusion and to the least disadvantage. It should have been done years ago, and the longer we put it off the worse it is going to be. Whatever may be said as to the expense of making the change it will be much more in ten years from now.

Mr. KNOWLAND. How would you answer, Mr. Stratton, the testimony of the gentleman who appeared here the other day and brought those samples of goods from China?

Mr. STRATTON. I suppose the French people like our own put up goods to meet the wants of their customers. China is divided up into certain sections. In Hongkong and some other places they are accustomed to English goods.

Mr. KNOWLAND. What they call spheres of influence?

Mr. STRATTON. They are perhaps accustomed to English goods and they want goods put up in a certain way. No doubt the French manufacturer will put up goods marked in yards to come to this country if required, just as our people often put up goods in metric packages when sent to metric countries.

That is the explanation; it is not because China is going to adopt the English system. They may use it in certain parts of China. I had a long talk with one of the Chinese commissioners when they were here recently, and he said that the tendency throughout the country is still to use the Chinese weights and measures, but that they are agitating that question, and that it was his opinion that if China makes a change it would be to the metric system.

Mr. KNOWLAND. I can not see what there is in this bill as proposed that would in any way interfere with our manufacturer meeting a special market in any other part of the world and putting up goods by any weights and measures anywhere in the world. Naturally, if they are selling goods in Egypt and they are using a system

there entirely different from ours, our American manufacturers could easily put them up in that special style; they could put a rooster on the goods or any other kind of a mark they wanted to.

Mr. STRATTON. I think that if manufacturers knew that that was all that was intended I think they would be content. The objection comes from the manufacturer who thinks that when the system goes into use he must at once change all his drawings and make all his tools over again.

Mr. KNOWLAND. That is the impression that those opposed to the law are sending out broadcast throughout the United States, that the minute this bill passes they will have to adopt the metric system, and they have written to me and asked me about it, and I have told them that it was not so, that it would simply apply to the Government, and if it didn't work satisfactorily nobody would be injured and we could go back to the old system, and that if it does work satisfactorily then they would be only too glad to adopt it.

Mr. STRATTON. It would be a great injustice to require a manufacturer to change existing drawings or existing machines; I don't believe it has occurred in the introduction of the system anywhere.

The CHAIRMAN. Would it be at all necessary under this bill or any other we might adopt—would that be necessary at all?

Mr. STRATTON. No, sir.

Mr. KNOWLAND. Even if it were adopted and compulsory throughout the United States, which we are not trying to do?

Mr. STRATTON. No.

The CHAIRMAN. As I understand it, some manufacturers have an idea that the introduction of the system would compel them to change their drawings to which they are manufacturing now. What is there, in your judgment, that would compel any such thing?

Mr. STRATTON. Nothing whatever. Of course one answer hardly suffices for all cases. If a manufacturer wished to redesign his machines in order to have even sizes, then he might have to make some new drawings.

The CHAIRMAN. Then he would be manufacturing——

Mr. STRATTON. His machine is already made; it already answers the purpose, and it would be ridiculous to do that. There is a good deal of misunderstanding about that whole question. Let us take a simple illustration: Suppose you break out that windowpane and wish to have it replaced. You could measure that window pane in any system of measures. If you measure it in the metric system, you measure it to the nearest millimeter and send it to the glazier and he puts it in. If we measure it in inches, we measure it to the nearest one-sixteenth of an inch. The size of the pane does not change. It is simply a question of what limit you can allow. Take the ordinary standard gas pipe established in this country and, I believe, in England. The dimensions of any size are so many thousandths of an inch.

Take that same table and translate it into millimeters and hundredths of a millimeter, and it is correct to the same degree of precision as it was before; it is as easy to use, and it doesn't change a thing. You would express that gas pipe under the new system in millimeters, and you would express the size of that window in millimeters instead of sixteenths of an inch. The same is true of all

structural materials; they can be expressed in metric units to the degree of accuracy required as well as in the customary units.

The CHAIRMAN. It would be as easy, I understand you to say, to express the ordinary measurements in metric terms as in the terms of our own system?

Mr. STRATTON. Just as easy. Take, for example, our wire gauges. There is great confusion in those wire gauges; each one is defined now in thousandths of an inch; they could be expressed as well in hundredths of a millimeter. Now, the time will come when the manufacturers will get together and establish a uniform wire gauge. It can be defined in thousandths of an inch or hundredths of a millimeter; it doesn't make any difference. The idea that an object has to be changed if you change its system of measurement is absurd, and yet many people have that notion.

The CHAIRMAN. You spoke of designing a new machine a moment ago. If you design a new machine would the old tools, the tools used in the manufacture of the old machine, suffice to manufacture the new machine?

Mr. STRATTON. Not in every case. You speak of tools, and I have noticed, in listening to the testimony that has been given before this committee, that because the witnesses and also those who have asked questions have used the word "tool" in different senses, a great deal of confusion has risen. The word "tool" is used in three or more distinct senses. In the first place, there are the measuring tools, the graduated scales and calipers that they use to measure with. Then, in the second place, there are the lathes and planers and shapers, which mechanics speak of as machine tools, and they ordinarily leave off the word "machine" and simply say "tools."

Mr. BOWERSOCK. Then there would be absolutely no change required?

Mr. STRATTON. Practically none; except in cutting metric screws. In that case any lathe can be made to cut metric-screw threads by translation gears, a device which is in use in machine shops. The third use of the word "tool," a distinct use of the word, is in connection with such tools as drills, reamers, arbors, and the fixed jigs that are gotten up and designed for a special machine. A shop that introduces the metric system must, of course, buy new measuring instruments, but that is a small matter. The workmen can work in one just as well as the other.

Mr. BOWERSOCK. The calipers, and everything of that character would be the same.

Mr. STRATTON. Yes; but they would be instruments with the new graduation on them.

Mr. BOWERSOCK. The caliper would be the same, though?

Mr. STRATTON. Yes; and so grocery men would have to have a new balance.

Mr. BOWERSOCK. Could they not have them for a time with the present system upon one side and the metric system upon the other?

Mr. STRATTON. Yes; in some cases; but they would not do that very long; they would discard the old just as soon as possible.

In the case of the machine tools no change is necessary. In the case of that third class of tools, the jigs and tools of that kind must be devised for that machine no matter what system you are working in. They are only made where you are going to manufacture tools in

great quantities. The drills, reamers, arbors, etc., would have to be changed if a shop desired to use only even sizes, which would be the case eventually.

The CHAIRMAN. And the change of a machine, whether it is measured in one system or another, would necessitate a change of that kind of tool?

Mr. STRATTON. How is that?

The CHAIRMAN. I say, a change in the size of your machine (you spoke of a new design) would necessarily necessitate a change in that particular kind of tool.

Mr. STRATTON. It would in some cases, but not all.

The CHAIRMAN. Whether you manufactured in one system or in another?

Mr. STRATTON. Yes, sir; in the case of special tools.

The CHAIRMAN. And if you design a new machine, the expense of that kind of tool would be no greater in the one measurement than in the other?

Mr. STRATTON. It would not, ordinarily.

The CHAIRMAN. Now, returning to the bill before the committee, I suppose the Government, if it wanted an engine or a sewing machine or a mowing machine or any other kind of a machine, would do about what an individual would do; it would order a machine to do certain work and ordinarily what inconvenience or expense would be occasioned to the manufacturer?

Mr. STRATTON. None whatever in the case of machines which are placed upon the market and sold as a definite thing, as an object.

The CHAIRMAN. Suppose the Government should see fit to order a machine different from some standard machine that was already being manufactured, what would be the expense to the manufacturer so long as it was a different machine, whether it was ordered in one measurement or the other?

Mr. STRATTON. That would depend entirely upon the kind of machine. An answer could hardly be framed to suit all cases. Such cases, I might say, would hardly arise. In my experience in the Government service I don't know of many machines that have been required where the Government desired anything more than that the would do a certain thing. That is, the dimensions are left to the manufacturer. I suppose the Navy Department sometimes designs engines. If those engines are to be made in large quantities, one condition will exist, but if a single engine is to be made another condition will exist. And there might be, in a case of that kind, if an order should go into a shop that had never used the metric system it would be a little puzzling for a while, but most machines do work to one size as well as to the other.

Our own manufacturers, when they get orders for machinery from foreign countries—I mean special machinery that is built to order—take the drawings and translate them in some cases and in other cases they work to the metric dimension; but it is a question that they must settle for themselves.

The CHAIRMAN. I don't think you understood my question precisely. Suppose the Government designed a new machine, a machine different from that manufactured by a concern to whom it gave the order. That would necessitate some new tools?

Mr. STRATTON. Yes.

The CHAIRMAN. It being a new machine the tools would be new, would they not, whether the machine was manufactured in one system or the other?

Mr. STRATTON. When you use the word "tools" what tools do you mean?

The CHAIRMAN. The jigs and templets and things of that character.

Mr. STRATTON. It would cost no more for those special tools. If you ask in regard to the measuring tools, I would say they would have to have a new set—if they did not have them already. The answer is different, depending on the kind of tools you mean.

The CHAIRMAN. Then, I take it from your answer that if the machine was a new machine the only extra expense would be in the purchase of the new measuring tools, provided they did not already have them?

Mr. STRATTON. Yes, sir; and perhaps some of the fixed tools, such as taps and dies and reamers and smaller tools. If the design involved even dimensions of the metric system they would have to get tools of that class. But after all, I think we can depend upon it that if a man has sufficient intelligence to design a machine he has sufficient intelligence to design it in a way which it can be made most economical and most practicable. A number of manufacturers have stated to me that while they don't fear this bill they are afraid of the Government martinet. Now, I don't think there is a need of fear. I haven't run across such individuals in the Government service——

The CHAIRMAN. You mean by the Government martinet, the man who would——

Mr. STRATTON. If a difficulty arose that was not foreseen, if a case arose where it was necessary to use judgment, that he would not use it; he would adhere rigorously to the letter of the law no matter what it would cost.

Such a person would be a martinet.

I should like to have it understood that all my answers in regard to the machinery, and so forth, are personal opinions. I have come in contact with manufacturing a good deal, but I don't wish to put myself up as an expert in those lines, and I have answered these questions because they have been asked me and to the best of my ability.

The CHAIRMAN. You have worked in machine shops, as I understand it?

Mr. STRATTON. I have been familiar with shop work practically all my life and with both systems; have made full wages as a machinist and as a carpenter.

The CHAIRMAN. Now, I would like your opinion as to the advisability and practicability of this legislation.

Mr. STRATTON. I think that it is advisable and that it is practicable. It will no doubt meet with difficulties, but if other countries have overcome those difficulties why can not we? I think it will introduce the metric system into the country with a minimum of confusion and difficulty, and that the result will compensate many times for any temporary inconvenience.

Mr. BOWERSOCK. And the sooner it is done the better.

Mr. STRATTON. I think so. I consider this as important a measure as there is before Congress.

The CHAIRMAN. You have made some investigation of the use, so far as regards the use of metric weights and measures in some foreign

countries, and it has been contended here that in France and in Germany and in other countries where they have adopted the system it is not in general use. What do you say about that?

Mr. STRATTON. I think that it is the weakest argument that has been proposed against the adoption of the metric system in this country. I have made very careful investigations in foreign countries in regard to the use of other systems. The exceptions that have been cited here are perfectly true; but if you ask a German or Frenchman if the introduction of the metric system into those countries has been successful he will hardly take you seriously; he doesn't understand why a man should ask such a question.

I took this matter up last summer with President Foerster, the president of the International Committee of Weights and Measures. He is a German; he is president of the international committee, and I think drew up the regulations for Germany when the metric system was adopted. There is no man in France or Germany who is more familiar with the subject than Professor Foerster. He was for a long time at the head of the German Institution of Weights and Measures. I think he was at the head of that institution when the change was made.

He state that the exceptions, when such exist, are in the industries. The same thing would, no doubt, exist here for a long time. Every country allows such exceptions. Suppose we adopt the metric system; suppose England does not, and that England orders chemicals from us put up in pounds and imperial gallons.

It would be ridiculous to suppose that we could not go on using the pounds or that the chemist here could not sell to the Englishman in pounds; it would be ridiculous to quote that as an argument that the metric system was not a success here. You might as well say that our monetary system is not a success because in certain outlying districts they use shillings, and in California they use bits, or to say that the Chinese monetary system is not in use in China because they use Mexican dollars. Trade conditions make those exceptions necessary. As long as we have the present system and France and other countries have other systems, there will be an intermixture, and the more we trade with each other the more that confusion and intermixture will be.

(Thereupon, at 12 o'clock, the committee adjourned.)

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, March 8, 1906.

The committee met at 10.30 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. We will be glad to hear any statement that Mr. Adamson desires to make.

STATEMENT OF MR. GEORGE P. ADAMSON, OF THE BAKER & ADAMSON CHEMICAL MANUFACTURING COMPANY, EASTON, PA.

Mr. ADAMSON. Mr. Chairman and gentlemen of the committee, we have been in business for twenty-four years in Easton, Pa., and in that time we have practically used the metric system throughout our

manufacturing. We find that it facilitates our work in a great many ways—owing to the ease of calculation and the ease of manipulation in different ways in regard to making up chemicals and diluting solutions and in all our calculations; owing to the ease in which we can calculate, simply having to move the decimal point in many cases. That in connection with the teaching of the men. We have just the ordinary workmen; some have been in grocery stores; we have one who was in a machine shop.

After the first day that boy, who came from a machine shop, had no trouble at all in dealing in the metric system; in fact he makes all his calculations—he is now the assistant in the laboratory—in the metric system. If we desire to make up any new chemicals in the laboratory, we quote to the workmen the different materials to be used and always do it in grams or meters or kilos. In putting up materials for consumers it is practically the same thing. In a day or half a day a man can weigh or measure very readily, without many mistakes; in fact, I don't know of any mistakes that have been made in weighing or measuring materials in kilos or grams or centimeters or anything of that kind.

Mr. KNOWLAND. May I ask a question here, Mr. Chairman?

The CHAIRMAN. Yes; if Mr. Adamson will answer it.

Mr. ADAMSON. Certainly.

Mr. KNOWLAND. In the case of any concern such as yours that might at the present time use another system, would the expense of changing amount to very much?

Mr. ADAMSON. Possibly twenty-five or a hundred dollars. You might have to get a few balances, a few measuring casks. In fact, practically all the measuring casks at this time are made in liters or grams.

The CHAIRMAN. How many men do you employ?

Mr. ADAMSON. We have about 56.

The CHAIRMAN. How many manufacturing chemists are there in the country?

Mr. ADAMSON. Do you mean true manufacturing chemists, or fellows that call themselves manufacturing chemists? Every man that puts up a patent medicine is a manufacturing chemist, you know. There are about 50 or 60 true manufacturing chemists, I should say.

The CHAIRMAN. That many who devote themselves exclusively to manufacturing chemicals?

Mr. ADAMSON. That many who manufacture chemicals exclusively; yes, sir.

The CHAIRMAN. And what system do they use, if they use any?

Mr. ADAMSON. They use the metric system.

The CHAIRMAN. Exclusively?

Mr. ADAMSON. Well, no; because the demand from people generally is not for the metric system; they say so many gallons or so many pounds, as a rule.

The CHAIRMAN. In manufacturing what system do they use?

Mr. ADAMSON. In manufacturing they use the metric system to a great extent, I should say more than one-half of the manufacturers use the metric system in making up their chemicals.

The CHAIRMAN. To whom do you sell?

Mr. ADAMSON. We sell to all the chemical laboratories throughout the country; we sell to Mexico; we sell to Canada, to England, and, in fact, we export quite a good deal.

The CHAIRMAN. And your orders come in in what?

Mr. ADAMSON. In both ways, both in pounds and according to the metric system, in kilos or liters.

The CHAIRMAN. And you fill the order how?

Mr. ADAMSON. According to the way it is ordered, and that is done by men with a mere—well, some of them haven't even a common school education; they have no trouble in filling the orders properly.

The CHAIRMAN. How long have you used the system in the conduct of your business?

Mr. ADAMSON. Ever since we started.

The CHAIRMAN. And how many years ago was it when you started?

Mr. ADAMSON. Twenty-two.

The CHAIRMAN. And what, if any, difficulty have you had during that time in training men to the use of the metric system of weights and measures?

Mr. ADAMSON. Practically none; they took to it the same as you would to the ounce.

The CHAIRMAN. Either in the use of the weights and measures or in calculations?

Mr. ADAMSON. Or in calculations. I think they find the metric system easier in calculations than with the ounce as the basis, because there you have the fractions, and in the metric system you have the tenths, which is an easier way to calculate.

The CHAIRMAN. What, if anything, do you know of the experience of others along the same line?

Mr. ADAMSON. I know that all chemists, all manufacturers I have talked to, speak of it in the metric system.

The CHAIRMAN. Speak of it, you say?

Mr. ADAMSON. When they are doing any work they say so many kilos, so many meters; it is practically the same as it is with the manufacturers of the centigrade thermometer; some use one and some use the other.

The CHAIRMAN. What would be the advantage, if there would be any, in a universal system or a uniform system of weighing and measuring?

Mr. ADAMSON. Well, there would be the advantage of always having the same measure. We would not have to furnish sometimes in quarts and sometimes in liters and sometimes in ounces and sometimes in grams and sometimes in pounds and sometimes in kilos.

The CHAIRMAN. As it is, every manufacturing chemist has to keep a set of both measures?

Mr. ADAMSON. Both scales; yes.

The CHAIRMAN. Measures and scales?

Mr. ADAMSON. Yes, sir.

The CHAIRMAN. So far as the manufacturing chemist is concerned, there would be no extra expenditure in the way of supplying himself with weights and measures in the metric system?

Mr. ADAMSON. Except possibly in the heavier scales; they might have to get some heavier scales with the metric system.

The CHAIRMAN. That was your question, Mr. Knowland?

Mr. KNOWLAND. Yes.

Mr. ADAMSON. But in their other work, in their laboratory and their manufacturing work, I don't think there would be any expense attached at all.

The CHAIRMAN. Would anyone like to ask Mr. Adamson any other question relative to his business or the use of weights and measures?

Mr. KNOWLAND. I presume the metric system is more universally used in your line of business, possibly, than in any other line of business at the present time?

Mr. ADAMSON. I think it is.

Mr. KNOWLAND. How are prescriptions filled generally?

Mr. ADAMSON. By apothecary measure. That would do just as well in the metric system; that would be a very good thing there, because they have but the two systems of weights and measures there; they have the apothecary scruples and grams, whereas if there was one system it would reduce it all to the one system, because you take an apothecary—he would be weighing in centimeters and measuring in liters, and now he has scruples and grams and all kinds of funny measures. Generally they use the metric system, though, in apothecary's work.

Mr. KNOWLAND. We generally pay for those funny figures, too.

Mr. ADAMSON. Yes; they are put on so you don't know what you are getting.

Mr. KNOWLAND. You don't know what the sentiment is among other people in your line, do you?

Mr. ADAMSON. No; I didn't expect to be here until I was invited yesterday.

The CHAIRMAN. Well, if there is no other question, I would like Director Stratton to finish his statement which he began the other day.

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES,
HOUSE OF REPRESENTATIVES,
Thursday, March 15, 1906.

The committee met this day at 11 o'clock a. m., Hon. James H. Southard in the chair.

The CHAIRMAN. Gentlemen, we have here Mr. F. W. Taylor, who is president of the American Society of Mechanical Engineers, and Mr. Gus C. Henning, of New York, who is also a member of that society. Have you any preference as to the order in which you gentlemen would like to speak to the committee? You have about twenty minutes apiece.

STATEMENT OF MR. GUS C. HENNING, OF NEW YORK CITY, MEMBER OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Mr. HENNING. I am ready, Mr. Chairman.

I wish to state my position in the matter as one due to the study of the various systems used in this country and Great Britain, France, Belgium, Austria, Germany, and Holland, and having used the systems in various countries, and having come in contact with

the great manufacturing concerns, studying where the expense of manufacturing lay. From all the evidence that I have been able to gather I think that it would be very advisable to introduce the metric system into this country, first, so as to produce absolute uniformity throughout the country, and, second, to increase our foreign relations in a commercial way.

I myself have had occasion to have machines changed so that they could be used in the countries using the metric system, and have had such changes made in this country without any question of any increased expense and without changes of machines or equipment.

Mr. WOOD. You say these changes involved no expense?

Mr. HENNING. No expense in equipment.

Mr. WOOD. What expense do they involve otherwise?

Mr. HENNING. The mechanical work of changing a scale or lever from one set of divisions to another by using the same standard and measuring instruments that are used in the works here for all other purposes. This was the particular case of converting the Emery testing machine so that it could be used for making measurements determining metric weights. The machine was built in Stamford, Conn., by the Yale and Towne Manufacturing Company, and while they had no apparatus to measure by the metric system, they used their own appartaus to convert the divisions on the scale beams from the American divisions in pounds into the metric divisions for kilograms. They have not found it necessary to use metric scales, as it was not even necessary to change the weights on the scales to the metric system, because all that was necessary was to change this one set of divisions so as to change their value.

Mr. WOOD. Does that involve some confusion?

Mr. HENNING. None whatever. The way they did it was simply to put on the drawing the value of spaces in inches and decimals, and divide the scale that way, and then put the figures opposite these divisions. It was regular routine work, such as dividing any other scale beam, and none of the men in the shop did know that that was the metric division.

Mr. WOOD. It was merely mechanical on their part?

Mr. HENNING. Yes; merely mechanical, so far as the work in the shop was concerned, and that is the usual way of building everything in shops. In many of the larger works, especially where duplicated work is produced, the measurements on the drawings are not used. The usual custom is to mark on the drawing, besides the dimensions, the number of gauge or standard to be used to produce that result, and the men have no apparatus to determine the actual dimensions. The way they do produce the usual dimensions is to have a gauge called A, B, or 60, or any other number, to fix the gauge. These gauges wear, because of their use, and as soon as they have become worn they must be ground to another shape or size, either larger or smaller, as it happens to be, and this constant change in the equipment of every shop goes on, and they could just as well, as these gauges wear away, change them to suit the metric standard as to any other United States standard. It would be a small matter to change them, and it would not be a matter of large expense to change the old standards which they have to any new standard as they become worn.

It has been frequently stated that all machine tools used for cutting screw threads and on work designed to the metric system would have to be thrown into the scrap heap or entirely rebuilt.

This is not true by any means.

The fact is as follows: Any machine provided with gears and a feed screw to produce work and threads to United States standards can be changed to turn out metric threads and work by merely adding one or two gear wheels which bear certain ratios between the pitch of the feed screw and metric scale. This would cost very little, and as it would be serviceable for all future work, only the cost of its wear and tear and interest on additional capital invested would be added to cost of production.

Mr. WOOD. Can you tell me why so many manufacturing concerns are sending letters to the members of the committee stating that in their judgment it would involve great expense and confusion if the Government were to adopt the weights and measures of the metric system?

The CHAIRMAN. We have only a few minutes allowed for each one of these witnesses, and we have two of them, and I would suggest that the witness be allowed to make his statement. I can explain about the letters. Do you not think that is a good suggestion?

Mr. WOOD. Yes; if you think it is better to go on, go ahead. Let it come up in the regular order, Mr. Chairman. I asked the question just for information.

Mr. HENNING. I can answer that question very easily by referring to the experience of William Sellers & Co., who had some experience that way. The general reason why manufacturers say that it will cost such vast sums to change to the metric system is because they have not studied the matter carefully, or else because they do not want to be bothered with anything except their regular routine work, and because they assume that the entire works must be reequipped at once. In the case of William Sellers & Co., it has been stated before this committee heretofore that they tried to build the Giffard injectors on the metric system and failed. Other shops have done the same thing with other apparatus and have been very successful. The failure of William Sellers & Co. to use the metric system in their injector shop was because the method they used was faulty, in that they did not make the men do what is done at the present time—that is, every man is to do exactly what he is told; that they do not work to dimensions at all, but simply work to gauges. The men were allowed to argue the matter with the foreman instead of being obliged to do just what they were ordered. As soon as you allow the men to argue with the management as to the advisability of doing one thing or another, it interferes with the work, and the foremen do not know what is being done, and as a result, in the injector shop of William Sellers & Co., there was no end of trouble and poor work was done, because the men were allowed to argue with the foreman as to what was best.

Mr. WOOD. Confusion did result?

Mr. HENNING. Yes; confusion and wrong manufacturing. They could not turn out their injectors as cheaply as they knew other work could be turned out; afterwards when they changed back to the other system they did reach an economic result. Other shops have found that it can be introduced, provided you make the men do what

the foreman knows he is right and won't allow the laborers and mechanics to try to use their own method and improve upon something that they know nothing about.

Mr. WOOD. This is the case with the Norton Grinding Company, of Worcester, Mass., who, when they sell their grinding machines to metric countries, merely change the divided disk to one arranged suitably for the metric measurements. This disk costs no more than one made to United States standards, and the two machines are sold for the same price.

Mr. HENNING. Decidedly so. It is a well-known fact that some of our manufacturers, like the Pratt & Whitney Company, of Hartford, are now turning out machinery made on the metric system, and it does not cost them one cent more than it did by turning them out on the United States standard, because their prices are identically the same, whether made on one system or on the other. I believe this is also true of many machines made for export by Warner & Swazey, of Cleveland, Ohio. Their foreign work is now turned out on the metric system, and they produce metric standards and gauges of all kinds alongside of the others, and it was not necessary to expend hundreds of thousands of dollars in their shops to do this work, contrary to the statement of many manufacturers that it would cost vast sums to change, intimating that they would have to throw away their old gauges. They never do throw away the old gauges in any shop. They have them changed to another size as soon as they become worn, and whether they be changed from one syste mto another, or to any one standard from another standard, it will cost exactly the same and in the course of time the supply or stock of gauges will pass from one system to another without expending the entire sum of money to equip the works all at once with a new set of gauges.

Mr. WOOD. Are these gauges repaired?

Mr. HENNING. Yes; they need grinding. They wear out because of friction. When you slip a guage over a piece of material to measure its size it will gradually wear, and in spite of the fact that the contact surfaces are hardened they wear. They also drop on the floor and bend and change in that way. It is just as cheap to change such a guage from the United States standard to the metric standard as it would be to change it to any other standard, and that will produce a guage as applicable to the metric system as well as to keep on using it for the United States standard, and then they could replace the old guage by a new one under the American standard if necessary.

Mr. WOOD. I understand they are ground?

Mr. HENNING. Yes, sir. Another thing, no shop ever has orders for all of their different machines at the same time. They may get a new order for a different kind of machine, and it might require a set of guages for this new machine. If it requires a new set of gauges, whether the United States standard or any other, and they have no likelihood of getting duplicate orders, the custom of our manufacturers is to charge the entire expense on the consumer—the buyer—and it would make no difference whatever whether they used metric gauges or United States standard gauges for any new work. No shop ever designs 15 different styles of machines at one time. The designing of new styles is a gradual development.

Mr. WOOD. The expense would come on the consumer; the public at large?

Mr. HENNING. Yes; that would be in any case whether they used the American standard or the metric standard. The expense of equipment is charged against the cost of producing a single machine. If, however, there is a chance of duplicating the same machine, then the cost of the special equipment is never charged against that one machine, the first one made. If they have a reasonable likelihood of getting duplicate orders they do not add the entire cost of the special equipment to the cost of a fresh machine, but add but a small percentage thereof. Therefore the statement that the entire cost of equipping will have to be added to the cost of the machine, thereby making it very much more expensive, is not based upon facts.

Mr. WOOD. What proportion would they be likely to add to the cost or price of a machine?

Mr. HENNING. That depends upon the number of machines of that pattern which would be required.

The CHAIRMAN. If it is a standard machine, it would be very little?

Mr. HENNING. If it is a standard machine and a large order, they would charge but a small fraction of the cost of the new gauges or standards in the cost of making each machine, and thus a new set of guages add a very small percentage to the cost of the machines because of the increased capital in the business. The percentage of cost of using gauges is very small indeed. If the establishment be a large one and the work produced a regular class of work, then the addition of a single new machine will add very little to the total cost or capital employed in the business, and it is simply a percentage for interest on the money employed, and it is apportioned to the actual amount of money required to build that one machine. That is added to the expense of producing such a machine. Of course if they were to produce their entire product in the metric system instead of by the United States standard at once, that would necessitate an addition to the capital necessary, but not cost of production. But such a thing never occurred and never would occur.

Therefore this statement that it would require an immense expenditure of capital to equip their plant with metric gauges is not founded on facts that actually exist in connection with production. It is well known that our wire gauges are rarely used, except in a general way. I am myself manufacturing now diamond dies for wire, and the size of the wire is never given otherwise than in decimals; and in that case it would make no difference whatever whether they used the metric system for the dies or the decimal system. They give the measurement in ten-thousandths of an inch, and in the electrical industry they use decimals or the metric system in all their designs, and when they put a thing in the shop they do not let the men use their foot rules, because they have no value whatever, but they have all standard gauges. Everything is done to a gauge, and not otherwise, and all the drawings have marked on them, in addition to the dimensions, the number of the gauge that is to be used to produce results. Of course, it would simplify the measurements throughout the country if only one standard were used.

Mr. WOOD. How extensively is the metric system already used in the United States among manufacturing concerns?

Mr. HENNING. The metric system at the present time is only used to a limited extent and mainly by some of our machine manufac-

turers who deal extensively abroad, and it is used very largely in the manufacture of scientific instruments.

The CHAIRMAN. In chemicals at all?

Mr. HENNING. In chemicals it is very largely used. All chemists use the metric system for calculations. Our manufacturers of scales are producing the metric scales and tapes in very large quantities. I have some in my pocket. The manufacturers of this country are all producing these scales because they are being used generally in a small way, but we can not find or trace for what purpose they are used in preference to the other.

The CHAIRMAN. I want to direct your attention more especially to this bill. Have you read the bill pending before the committee?

Mr. HENNING. Yes; I have read the bill.

The CHAIRMAN. Now, it is stated by some manufacturers if this bill were enacted into law those doing work for the General Government would be put to considerable expense and annoyance. What is your judgment about that; and if that is so, how would it come about?

Mr. HENNING. It is my opinion that it would not increase the cost of manufacturing materially. The expense that would be added would be in the drafting and designing office, in comparing the dimensions given with the standard gauges that they are using in their shops.

The CHAIRMAN. As I understand you, that would occur only in a case where, for instance, the Government orders one machine or an article in a new design?

Mr. HENNING. Yes, sir; in a new design.

The CHAIRMAN. Let me ask you another question: How would it affect the manufacturer as to the reproduction of any standard article that he now makes?

Mr. HENNING. It would affect him very slightly indeed, because the same apparatus used to determine dimensions at first would be used later on.

The CHAIRMAN. How would it affect him at all?

Mr. HENNING. It would not necessarily increase the cost of manufacture, for this reason, as I explained before: If a single apparatus is made, the gauges are not made for such an apparatus. Gauges are only made for apparatus that is manufactured in large quantities, and when gauges are then made their cost is insignificant compared with the cost of all the work produced with their use.

The CHAIRMAN. I want to call your attention to a little testimony that appeared before this committee. Perhaps I do not understand it. Mr. Towne was before the committee—Mr. Towne, of the Yale-Towne Manufacturing Company. He manufactures locks.

Mr. WOOD. What page is that?

The CHAIRMAN. On page 112 of the printed hearing. I will read from this hearing. I said to Mr. Towne [reads]:

You make a lock and you make a key to fit it, and it does not make any difference what system is used.

Mr. TOWNE. That is right, and we make the dimensions of our lock, say a line of padlocks, in fractions of an inch, an inch and a quarter, an inch and a half, 2 inches, 3 inches, and so on. The buyer in the metric market does not care anything about that.

The CHAIRMAN. He wants so many locks.

Mr. TOWNE. No; he wants an approximate size. He takes up our catalogue, sees the size he wants, finds the price satisfactory, and he buys it. He does not care anything about the standard measurement we use in making that lock.

That was during the testimony of Mr. Sellers. Then Mr. Towne said, on page 128 [reads]:

The existence of a standard, Mr. Chairman, requires some method of maintaining it. You must have a master model or an accepted gauge—a record to go back to and refer to, which you preserve, as the standard foot is recorded and preserved in the Smithsonian Institution in this city. Somebody must keep that standard, and from it must be reproduced the working gauges which go out to the thousands of mechanics all over the country, with which they can measure work as they produce it, and the devices used to determine when a piece of mechanism is perfect, and fit to go into use, and to determine when an article already in use has become so worn or disfigured as no longer to conform to the standard, and no longer will interchange with other similar pieces.

Then speaking of this bill, or a similar bill, he says, on page 129 [reads]:

Mr. TOWNE. It would compel all who undertook Government work to adopt the metric system in their tools and gauges for Government work, and yet to maintain their present equipment of tools and gauges for use in all their other business, or else it would compel them to decline to bid on Government work. Take my own company, for example. About 2½ per cent of our annual business is done with Departments of the United States Government. If we were required to substitute metric sizes for our standard sizes, the game would not be worth the candle. We would simply withdraw from Government business. The products which the Government buys from us are commercial products. We simply sell to the Government part of our regular commercial output. We do not make anything especially for the Government.

Now, I want to ask you, if they now sell to the Government part of their commercial output, what would it require of them provided the Government continued to order in the same way that Mr. Towne says they ordered? How would it compel Mr. Towne to do one thing? How would it affect him as to a single dollar of expense?

Mr. HENNING. Mr. Towne has answered that question on page 112 himself. He says: "When our gauges get out of shape we must compare them with the standard and get them into shape again." The standard with which he compares is the measuring machine, the very machine which he used in laying off the scale on the beam to which I referred before. Therefore, as he will use these gauges continuously, because he sells 2½ per cent of his product to the Government, he will keep on using these gauges in the future, and therefore he can produce these gauges, not by comparing with his standard, which is divided on the American standard, but simply takes measurements on that machine to produce gauges that will answer for the work and furnishes it to the Government according to metric measurement.

The CHAIRMAN. You will observe that he says that they look at their catalogue and see a lot that suits them and order an approximate size. If that is so, if the Government order comes in to the Yale-Towne Company in that way, say, for a thousand locks, I want to ask you what there is to even hint at compulsion, as far as the Yale & Towne Lock Company is concerned, to do a single thing that would cost them a single cent of expense?

Mr. HENNING. As the Government requires only approximate dimensions in these locks, there is no question about it that most of the standard gauges at the Yale & Towne Company's Works would

also answer to fill the specifications and requirements of the Government's work, and the cost of manufacture would not be increased one cent.

The CHAIRMAN. I still do not think you understand my question. Suppose the Government ordered a thousand of lock No. 4 of the Yale & Towne Lock Company. What would the Yale & Towne Lock Company have to do that would cost them a cent extra in order to furnish this thousand locks?

Mr. HENNING. In addition to the gauges that are sufficiently close, they would have to correct some of their worn gauges to suit the requirements for the new locks, but this would not increase cost of production.

The CHAIRMAN. What requirements would there be in the new that would not be in the old?

Mr. HENNING. There would not be any. It would not cost them any more than to keep the gauges in condition for the old style of locks. They would have to do that anyway.

Mr. WOOD. When Mr. Towne says it would compel them to decline to bid upon Government work, you think he is mistaken?

Mr. HENNING. Yes. I know Mr. Towne very well. I know him personally. It does not seem possible, with the great number of gauges that they have, and the great amount of repairing of gauges that they have to do all the time, that it would cost one cent more to produce the new work than work under the old standard, because the gauge would have to be put in shape for the old work just as for the new.

Mr. WOOD. Did not other manufacturers give virtually the same testimony?

Mr. HENNING. Yes.

Mr. WOOD. Do you not think they are mistaken, too?

Mr. HENNING. Yes.

Mr. WOOD. Do they lack education in the matter?

Mr. HENNING. Yes; they lack education in the matter. Most of them have not tried it; and Mr. William Sellers's statement that they failed in introducing the metric system in their injector shop has had a very strong influence upon other manufacturers, deterring them from trying to use the metric system in their shops, because Mr. Sellers, when he made these experiments, was very important and influential, and what he said was generally believed to be correct.

The CHAIRMAN. They are still using the metric system in making these Giffard injectors?

Mr. HENNING. Yes, sir.

Mr. WOOD. Do you think the fact that we have not a system that conforms to the European standard is any special detriment to the manufacturers in supplying foreign trade?

Mr. HENNING. Yes, sir; our consuls have reported repeatedly that the reason why we can not do business elsewhere is because they can not use our materials and productions, and they can not understand them.

Mr. WOOD. The demand for the adoption of the metric system, therefore, comes largely from those who have international trade relations?

Mr. HENNING. Yes, sir.

Mr. WOOD. As a matter of fact, do you find considerable opposition among manufacturers generally throughout the country whose output is mostly along domestic lines?

Mr. HENNING. Yes, sir; among machine manufacturers particularly.

Mr. WOOD. And they state it on the graund that they think it would cost them additional expense and annoyance?

Mr. HENNING. Yes, sir.

Mr. WOOD. And you think their views and opinions on the matter are mistaken?

Mr. HENNING. Yes, sir.

Mr. WOOD. I see the first date of this hearing is January 21, 1904. That is over two years ago.

The CHAIRMAN. Yes; these were hearings taken on an almost precisely similar bill.

Mr. WOOD. Is it not a little remarkable that they have not come to the correct conclusion as to the facts on the matter by this time—that is, the manufacturers throughout the country?

Mr. HENNING. They have been too busy since to take up a new thing like this and study it as thoroughly as it requires. They have not had the time to go to the bottom of this study, except such as were compelled to study it because of the requirements of their business or because of the special interest taken in it. They can not be bothered by such a thing. They are making money enough on the old standard.

Mr. WOOD. You think their opinions were expressed upon information that was not fully digested?

Mr. BOWERSOCK. I think that can be illustrated by a letter I received a few days ago from a prominent manufacturer of scales and steam engines in my district. In making the statement to me they said their capital stock was $200,000. They estimated it would require the entire amount of their capital stock to put them in shape to manufacture under the metric system—an assertion made evidently without any thought or examination of the subject or of this bill.

The CHAIRMAN. What do you say the capital stock was?

Mr. BOWERSOCK. Two hundred thousand dollars. [Laughter.]

Mr. WOOD. I want to say that I have received a number of letters every day recently from manufacturers in my district expressing fear that they would be put to expense and annoyance; and if they are mistaken in their views I want to be informed as to the matter.

The CHAIRMAN. Has anyone else a question he would like to ask of the witness? If not, we will hear from Mr. Taylor.

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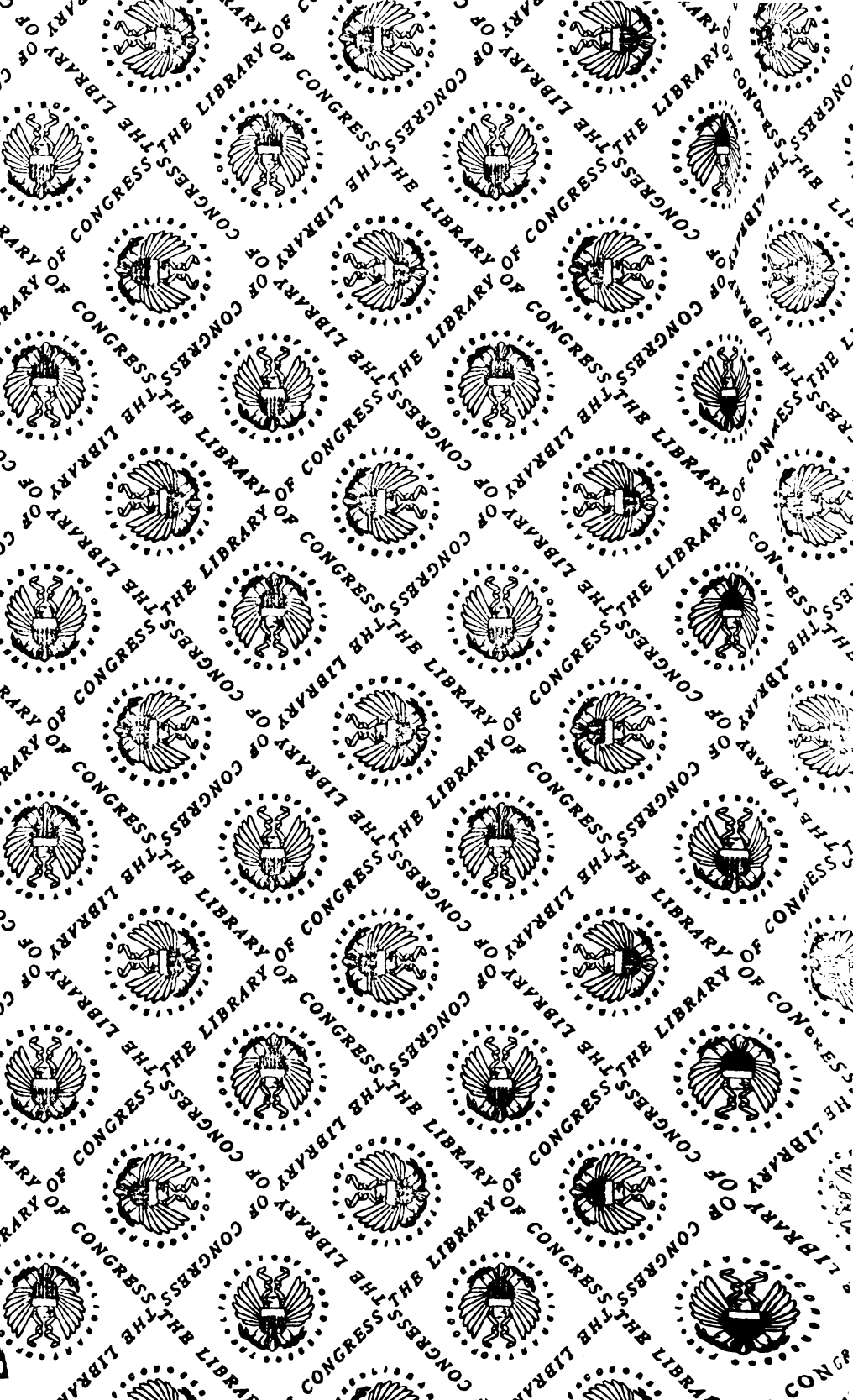
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